

EDF Title: **TSF-03 EXCAVATION QUANTITIES CALCULATIONS**
 Project No.: 2000-096 Project Title: OU 1-10, TSF-26 REMEDIATION
 Project Specific Activity: EXCAVATION QUANTITIES CALCULATIONS

Problem Statement:

Calculate the Excavation and Fill Quantities for the TAN Burn Pit - TSF-03 Remedial Action Operations. Includes the following breakdown of material types:

- Excavated "Clean Materials" [No Burn Waste Visually Present] - Stockpiled at Site
- Excavated "Contaminated Materials" [Visually Present Burn Materials] - Disposed of at ICDF
- Required Imported Engineering Backfill Materials
- Required Imported Topsoil

Summary of Conclusions:

TSF-03 Site:

- Excavated "Clean Materials" ==> 2,418 cubic yards
- Excavated "Contaminated Materials" ==> 751 cubic yards
- Imported Engineering Backfill Materials ==> 804 cubic yards
- Imported Topsoil ==> 196 cubic yards

REVIEW AND APPROVAL SIGNATURES:

	R/A	TYPED NAME/ORGANIZATION	SIGNATURE	DATE
PREPARED BY:		D. J. Kenoyer	<i>D. J. Kenoyer</i>	21-05-03
CHECKED BY:		KEVIN SHABER	<i>Kevin Shaber</i>	10/20/03
INDEPENDENT REVIEWER		OEB		
APPROVAL:		GARY MECHAM	<i>Gary Mecham</i>	10/21/05

Distribution:

Registered Professional Engineer's Stamp (if required)

EDF Title: **TSF-03 EXCAVATION QUANTITIES CALCULATIONS**
Project No.: 2000-096
Project Title: OU 1-10, TSF-03 REMEDIATION
Prepared by: D.J. Kenoyer Date: 28-Jul-03 Checked by:

EDF No. 096-010
Rev. No.: 0
Page 2 of 3
Date:

PROBLEM STATEMENT:

TSF-03 Site Remediation Operations require the removal of overburden above the TAN Burn Pit. The excavation must be sized sufficiently large to allow all remedial operational activities to be performed including:

- Definition of Waste within the TAN Burn Pit - Waste Pit Boundary
- Removal of Clean Overburden and Stockpiling on Site
- Removal of Burn Pit Waste and Placement into Waste Containers
- Equipment and Personnel Access

ASSUMPTIONS:

The Assumptions utilized in the performance of these calculations are outlined below:

- Soil Classification Allows the Utilization of 1:1 Side Slope due to Soil Cohesion and Stability [Conclusion from soil sampling radiological survey data - accomplished in May 2003 by BBWI]
- General TSF-03 is Not Radiologically Contaminated
- Compaction Factor of 7.0% was utilized in calculating the cubic yards of Engineered Backfill Materials needed to be imported from TAN Pit [located North of SMC]
- Compaction Factor of 5.0% was utilized in calculating the cubic yards of Topsoil Materials needed to be imported from TAN Pit [located West of WRRTF]

REFERENCES:

CALCULATIONS / ANALYSIS:

See Attached Excel Spreadsheet Calculations based upon TSF-03 Site Physical Configuration and above stated considerations for excavation sizing development.

INEEL BBWT RFP-394 RD/RA Work Plan for WAG 1-10



==> TSF-03 Burn Pit - Excavation Quantities Calculations

WAG 1-10 Sites TSF-26, TSF-03, and WRRTF-01

INTREPID prepared Revision 0 dated - 18-Jan-2003, by DJ Kenoyer, Checked by
 INTREPID prepared Revision 1 dated - 23-Jan-2003, by DJ Kenoyer, Checked by
 INTREPID prepared Revision 2 dated - 30-Jan-2003, by DJ Kenoyer, Checked by
 INTREPID prepared Revision 3 dated - 08-Mar-2003, by DJ Kenoyer, Checked by
 Checked 90% Design - 17-May-03, DJ Kenoyer, Verified by Shaun Dustin

==> Due to Field Collected Data - Pictures & Field Walkdown
 ==> Due to Verified Field Survey Data - Burn Pit Configuration

Option 3 - Configuration [Small - Rectangular ==> TSF-03 Burn Pit]

Description	width (ft)	Access Slope	length (ft)	depth (ft)	Area (square feet)	volume (cubic feet)	(cubic yards)
Main Excavation							
- Bottom	26.0		64.0				
- Bottom w/Access	50.0	12.0	88.0		4,400.0		
- Top	74.0	1.0	112.0		8,288.0		
				12.0	6,344.0	76,128.0	2,819.6
Ramp							
- Bottom		12.0	80.0		960.0		
- Top		33.0	80.0		2,640.0		
				10.5	1,800.0	9,450.0	350.0
							3,169.6
Waste - Burn Layer							
- Bottom	26.0		64.0		1,664.0		
- Top	26.0		64.0		1,664.0		
				9.0	1,664.0	14,976.0	554.7
Waste Intrusion - Under Burn Layer							
- Bottom	26.0		64.0		1,664.0		
- Top	26.0		64.0		1,664.0		
Assumed Depth of Intrusion ==>				2.0	1,664.0	3,328.0	123.3
Waste Intrusion - Adjacent to Burn Layer							
		depth	width	length	each		
- Sides		11.0	1.0	64.0	2.0	1,408.0	
- Ends		11.0	1.0	26.0	2.0	572.0	
						1,980.0	73.3
Clean Backfill - Above Burn Layer							
- Bottom	26.0		64.0		1,664.0		
- Top	26.0		64.0		1,664.0		
Assumed Depth of Clean Backfill ==>				1.5	1,664.0	2,496.0	92.4
						751.3	vs. 4,745.4
						2,418.3	vs. 5,535.7
Soil Shrinkage Factor ==>	7.0%					803.8	vs. 5,219.9
Imported Topsoil							
		6 inches thickness					
Top of Excavation	74.0		112.0		8,288.0		
Top of Ramp	22.5		80.0		1,800.0		
					10,088.0	186.8	
Soil Shrinkage Factor ==>	5.0%						196.2
Excavation Spoils File No. 1							
- Bottom	80.0		90.0		7,200.0		
- Top	50.0		60.0		3,000.0		
				15.0	5,100.0	76,500.0	2,833.3
Waste Boxes for Burn Layer Waste							
						cubic feet	cubic yards
Standard Steel Box	4.0	4.0	6.0	10,000 lbs		96.0	3.6
Fabric Soil Sack	6.0	6.0	10.0	25,000 lbs		360.0	13.3
Roll-Off Container	3.5	7.2	22.0	lbs		551.3	20.4
						751.3	cubic yards
Waste Expansion Factor ==>	7.0%					803.8	cubic yards
						227	each
Cost for Standard 40" x 40" x 60" Steel Waste Container at the INEEL ==>	\$					550.00	each
Estimated Cost for Steel Waste Containers ==>	\$					124,850	
						61	each
Cost for Standard Soil Sack Container at the INEEL ==>	\$					300.00	each
Estimated Cost for Fabric Waste Containers ==>	\$					18,300	
Number of Standard 20cy Roll-Off Containers & Liners Required ==>						41	each
Cost for Standard Roll-Off Container at the INEEL ==>	\$					-	each
Cost for Standard Roll-Off Container Liner at the INEEL ==>	\$					250.00	each
Estimated Cost for Roll-Off Waste Container Liners ==>	\$					10,250	
Cost for Standard Roll-Off Container - RENTAL Fees ==>	\$					-	per week
Standard Roll-Off Container - REQUIRED ==>						41	each
Estimated Cost for Roll-Off Waste Containers ==>	\$					-	
Estimated Total Cost for Roll-Off Waste Containers ==>	\$					10,250	

EDF Title: Radiological Modeling Calculations				
Project No.: 2000-096		Project Title: OU 1-10, Group 3		
<p>Problem Statement:</p> <p>Model runs were performed to evaluate what expected radiation fields may be present during the proposed remediation operations.</p>				
<p>Summary of Conclusions:</p> <p>Various scenarios were evaluated during the different stages of design. The results of the models runs are shown in the summary table. Similar type modeling will need to be performed and actual radiation field measurements will be obtained in efforts to develop the actual ALARA review and applicable Radiation Work Permits.</p>				
Review and Approval Signatures:				
		Printed Name	Signature	Date
Prepared by:		Henry Peterson	<i>Henry Peterson</i>	12/3/03
Checked by:		DJKELOYSR	<i>DJKELOYSR</i>	03.12.03
Approval:		GARY MECHAN	<i>Gary Mechan</i>	12/3/03
Distribution:				
Professional Engineer's Stamp (if required)				

EDF Title: RADIOLOGICAL MODELING CALCULATIONS				
Project No.: 2000-096		Project Title: OU 1-10, GROUP 3, TSF-26 REMEDIATION		
Project Specific Activity: PM2A TANK WASTE RADIOLOGICAL MODELING CALCULATIONS				
<i>Problem Statement:</i>				
<p>Radiological Model runs were performed to evaluate what expected radiation fields may be present during the proposed remediation operations:</p> <ul style="list-style-type: none"> • Work Around PM2A Tanks ... totally exposed and with various levels of soil cover • Work Around Waste Containers ... Full and 2/3 Full of Waste Materials ... totally exposed and with 1/8" and 1/4" lead sheet shielding • Work Around BROKK and Vacuum Hose Equipment System • Entry into the PM2A Tank halves after most waste materials removed with vacuum system 				
<i>Summary of Conclusions:</i>				
<p>Various scenarios were evaluated during the different stages of design. The results of the models runs are shown in the summary table. Similar type modeling will need to be performed and actual radiation field measurements will be obtained in efforts to develop the actual ALARA review and applicable Radiation Work Permits.</p>				
REVIEW AND APPROVAL SIGNATURES:				
	R/A	TYPED NAME/ORGANIZATION	SIGNATURE	DATE
PREPARED BY:		Henry Peterson		
CHECKED BY:				
INDEPENDENT REVIEWER				
APPROVAL:				
Distribution:				
Registered Professional Engineer's Stamp (if required)				

PROBLEM STATEMENT:

OU 1-10, Group 3, TSF-26 Site Remediation Operations require the cutting and removal of the PM2A Tanks [V-13 (East Tank) and V-14 (West Tank)] halves in conjunction with waste removal operations. Radiological Modeling is necessary to predict the personnel exposure fields expected during these remediation operations.

ASSUMPTIONS:

The Assumptions utilized in the performance of these calculations are outlined below:

- Waste Sampling Data from PM2A Tanks
- Microshield Modeling Software

INDEX OF EDF INFORMATION - DESIGN & CALCULATIONS:

EDF-096-011	pages 1-3
Radiological Aspects PM2A Tanks	pages 4-5
MicroShield Model Runs	See Table 1

SUMMARIZATION OF RESULTS:

Table 1 summarizes the results from the various radiation field modeling that was performed in association with the design of the WAG 1, Group 3, TSF-26, remedial design and remedial action work plan development activities.

Table 1. Estimated radiation level associated with the TSF-26 remedial activities.

Radiation levels associated with working near the one tank while the other tank remains in place.	Pages 6-9	129 to 146 mR/hr
With 1 ft. of soil cover	Pages 10-13	5.8 to 5.9 mR/hr
With 18" of soil cover	Pages 14-17	0.94 to 0.92 mR/hr
With 24" of soil cover	Pages 18-21	0.146 to 0.148 mR/hr
Radiation levels related to exposed PM2A Tanks and PM2A Tank Site Boundary Fencing [Center of Mass of Waste is 66 lineal feet from PM2A Site Boundary Fence / Snake Avenue]	Pages 22-26	6.9 mR/hr
Radiation levels related to a filled waste container [12'0" x 6'6" x 6'0"] "On Contact"	Page 27-28	264 mR/hr
Radiation levels related to a filled waste container [12'0" x 6'6" x 6'0"] "On Contact" with 6" Concrete Cover	Pages 29-30	17.6 mR/hr
Radiation levels related to a filled waste container [12'0" x 6'6" x 6'0"] "On Contact" with 9" Concrete Cover	Pages 31-32	5.0 mR/hr
Radiation levels related to a filled waste container [6'0" x 4'0" x 4'0"] "On Contact"	Pages 33-34	206 mR/hr
Radiation levels related to a filled waste container [6'0" x 4'0" x 4'0"] "On Contact" with 1/8" Thick Lead Sheet Shielding	Pages 35-36	61 mR/hr
Radiation levels related to a filled waste container [6'0" x 4'0" x 4'0"] "On Contact" with 1/4" Thick Lead Sheet Shielding	Pages 37-38	36 mR/hr
Radiation levels related to a 2/3 filled waste container [6'0" x 4'0" x 4'0"] "On Contact"	Pages 39-40	194 mR/hr
Radiation levels related to a 2/3 filled waste container [6'0" x 4'0" x 4'0"] "On Contact" with 1/8" Thick Lead Sheet Shielding		
Radiation levels related to a 2/3 filled waste container [6'0" x 4'0" x 4'0"] "On Contact" with 1/4" Thick Lead Sheet Shielding		
Radiation levels related to sediment deposits inside the vacuum line.	Pages 41-44	1 to 6 mR/hr
Radiation levels present for a person operating the Brokk manipulator (at the unit)	Pages 45-56	185 to 538 mR/hr
Radiation levels related to entry into the tank after the major quantity of tank content materials have been removed from the tank using the vacuum system	Page 57	51 mR/hr
Waste Bin with 25% Tank Sludge [12'0" x 1'3" x 0'11"]	Pages 58-59	587 mR/hr

Radiological Aspects of and Controls for the PM-2A Tank Remediation Efforts

Remediation of the PM-2A tanks will involve the transfer of radioactive sludge and diatomaceous earth from the PM-2A tanks to a steel disposable waste bin with the use of a vacuum system. This document describes the radiological aspects of the remediation process and the controls that are needed to protect personnel from excessive radiation exposure both from direct radiation and from uptake of airborne radionuclides, to ensure the operation proceeds smoothly without problems resulting from operational oversight, and to ensure the airborne effluent from the operations is within the operational limits.

For this remediation effort, two tanks need to have the radioactive sludge removed from them. To prevent the second tank from being an unnecessary radiation source to operations personnel, care should be taken when removing overburden from the tanks to leave enough soil over the second tank to attenuate the radiation field from this tank to levels that will not add appreciable dose to the operations personnel as they process the first tank. To determine the amount of soil that needs to be left over the second tank, the MicroShield code was used. The sludge in the tank was modeled as a rectangular source with a length of 50 feet, a thickness of 3.9 inches, and a width of 36 inches. The density of the sludge is assumed to be 2.0g/cm^3 and have an elemental composition similar to concrete. The soil shield is assumed to have a density of 1.8g/cm^3 and also have an elemental composition similar to concrete. Scale drawings of the tanks show that there is between 4.5 and 5 feet between the tanks at the tank centerline. Assuming that both tanks have been uncovered to remove all shielding from both sources, the radiation field between the two tanks as a position midway along the length is calculated to be about 300mRem/hr. At the end of the tanks, the radiation field would decrease to about 260mRem/hr. If soil is left as shielding on one tank, the radiation field between the two tanks will decrease to almost 50% of these values. Calculations were performed to illustrate the value of 12, 18, and 24 inches left covering the tank that is not remediated. The percentage of the calculated radiation field due to one tank through three thicknesses of soil (12", 18", and 24") are 4.0%, 0.6%, and 0.1%. Obviously, the more soil that can be left surrounding/over the second tank, the better, but, based on these calculations, 18 inches of overburden would reduce the radiation field to a contribution of 0.6% of the dose rate from the second tank, or about 0.9mRem/hr.

Ideally, the sludge will be dry and able to be broken into small enough pieces that the air stream of the vacuum system will be able to completely transport the material to the waste bin. If the sludge contains moisture such that it is unable to be broken into small enough pieces, the material will be deposited within the vacuum line between the vacuum head and the waste bin, thus creating a line source of radioactive material that will create radiation exposure to operations personnel. Clearly, a line with a smooth interior will be superior to one with a wire stiffener that has an internal corrugation. Calculations are performed to show the effect of a small amount of tank sludge deposited uniformly within the vacuum line. The calculations assumed 5 grams of sludge per inch of line. With this small amount of soil in the line, the radiation field is calculated to be

2.6mRem/hr at a foot from the line. As sludge accumulates in the line, the radiation dose rate will increase proportionally to the amount of sludge. Therefore, if the line can be kept clean, the dose rate will be minimal.

After the majority of the sludge has been cleaned from the tank by the BROKK manipulator arm, a small amount of sludge is expected to remain in the corner at the ends of the tank and possibly at the rib locations of the tank. When personnel enter the tank to clean these remnants of sludge from the tank, a slight radiation field will be presented by these remaining sludge deposits. To estimate the radiation field presented to personnel, a 4-foot long heel conservatively containing 1 cubic foot of sludge is assumed. The calculated radiation field from this heel is about 50mRem/hr. Since the field is proportional to the amount of sludge, the field will likely be less than the calculated value.

The next item to consider is the placement of the waste bin. It should be placed remotely (or shielded) from items that may need maintenance such as the vacuum pump, the roughing filters, etc. The radiation field from the waste bin was calculated by the MicroShield code with the bin filled to a depth of 6.5 feet. According to the volume and weight of the sludge, and diatomaceous earth, the density of a mixture of the two materials is 0.60 g/cc. For this model, the diatomaceous earth is assumed to be evenly mixed with the tank sludge. According to Intrepid Technology and Resources, Inc., Dwg. #M-1 rev. A, the waste bin is 12 feet long by 6 feet wide by 7 feet high. (These dimensions have now been revised to 6'x4'x4'.) According to the MicroShield calculation, the dose rate at 1 foot from the middle of the side of the waste bin would be about 260mRem/hr. This value could be higher or lower since the calculation assumed that the activity is evenly dispersed in the total volume of waste from the two tanks. Clearly, any maintenance on the vacuum pump, which is located on the side of the waste bin, would have to involve substantial shielding to protect personnel. A slab of regular concrete 6 inches thick would reduce this radiation field to 18mRem/hr or to 6.8% of the dose presented by the waste bin. If the concrete is 9 inches thick, the field is reduced from 260 to 5mRem/hr or about 1.9% of the bin dose rate.

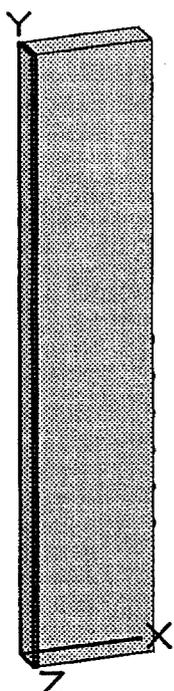
All calculations are appended for reference.

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company

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 Date: _____
 By: DM
 Checked: 5/12/03

Case Title: Tank 709
 Description: Rad field from sediment shielded with no soil
 Geometry: 13 - Rectangular Volume



Source Dimensions

Length	9.86 cm	3.9 in
Width	91.44 cm	3 ft
Height	1.5e+3 cm	50 ft

Dose Points

	X	Y	Z
# 1	305.8 cm	762 cm	45.72 cm
	10 ft 0.4 in	25 ft 1 ft 6.0 in	
# 2	305.8 cm	670 cm	45.72 cm
	10 ft 0.4 in	21 ft 11.8 in	1 ft 6.0 in
# 3	305.8 cm	578 cm	45.72 cm
	10 ft 0.4 in	18 ft 11.6 in	1 ft 6.0 in
# 4	305.8 cm	486 cm	45.72 cm
	10 ft 0.4 in	15 ft 11.3 in	1 ft 6.0 in
# 5	305.8 cm	394 cm	45.72 cm
	10 ft 0.4 in	12 ft 11.1 in	1 ft 6.0 in
# 6	305.8 cm	302 cm	45.72 cm
	10 ft 0.4 in	9 ft 10.9 in	1 ft 6.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.37e+06 cm ³	Concrete	2
Shield 1	295.94 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : Grove

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup

The material reference is : Shield 1

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

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Results - Dose Point # 1 - (305.8,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	8.824e+00	2.058e+01	8.745e-02	2.039e-01
0.04	5.603e+09	5.907e+00	2.143e+01	2.612e-02	9.479e-02
0.05	2.678e+07	5.566e-02	2.818e-01	1.483e-04	7.506e-04
0.1	2.096e+08	1.859e+00	1.055e+01	2.844e-03	1.614e-02
0.2	3.538e+07	8.338e-01	2.936e+00	1.472e-03	5.181e-03
0.3	4.807e+03	1.937e-04	5.349e-04	3.674e-07	1.015e-06
0.4	3.696e+06	2.175e-01	5.175e-01	4.239e-04	1.008e-03
0.5	1.320e+06	1.042e-01	2.237e-01	2.046e-04	4.391e-04
0.6	3.560e+11	3.572e+04	7.099e+04	6.973e+01	1.386e+02
0.8	2.148e+08	3.143e+01	5.584e+01	5.979e-02	1.062e-01
1.0	4.552e+09	8.915e+02	1.474e+03	1.643e+00	2.718e+00
1.5	4.594e+09	1.520e+03	2.241e+03	2.557e+00	3.770e+00
TOTALS:	3.945e+11	3.818e+04	7.482e+04	7.411e+01	1.455e+02

Results - Dose Point # 2 - (305.8,670,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	8.803e+00	2.053e+01	8.724e-02	2.034e-01
0.04	5.603e+09	5.892e+00	2.138e+01	2.606e-02	9.455e-02
0.05	2.678e+07	5.552e-02	2.811e-01	1.479e-04	7.487e-04
0.1	2.096e+08	1.854e+00	1.052e+01	2.837e-03	1.609e-02
0.2	3.538e+07	8.316e-01	2.926e+00	1.468e-03	5.164e-03
0.3	4.807e+03	1.932e-04	5.331e-04	3.664e-07	1.011e-06
0.4	3.696e+06	2.169e-01	5.156e-01	4.227e-04	1.005e-03
0.5	1.320e+06	1.039e-01	2.229e-01	2.040e-04	4.376e-04
0.6	3.560e+11	3.562e+04	7.074e+04	6.952e+01	1.381e+02
0.8	2.148e+08	3.134e+01	5.564e+01	5.961e-02	1.058e-01
1.0	4.552e+09	8.888e+02	1.469e+03	1.638e+00	2.708e+00
1.5	4.594e+09	1.515e+03	2.233e+03	2.549e+00	3.756e+00
TOTALS:	3.945e+11	3.807e+04	7.455e+04	7.389e+01	1.450e+02

Results - Dose Point # 3 - (305.8,578,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	8.734e+00	2.036e+01	8.656e-02	2.018e-01
0.04	5.603e+09	5.846e+00	2.120e+01	2.585e-02	9.377e-02
0.05	2.678e+07	5.508e-02	2.787e-01	1.467e-04	7.425e-04
0.1	2.096e+08	1.839e+00	1.041e+01	2.814e-03	1.593e-02
0.2	3.538e+07	8.245e-01	2.894e+00	1.455e-03	5.108e-03
0.3	4.807e+03	1.915e-04	5.272e-04	3.632e-07	1.000e-06
0.4	3.696e+06	2.150e-01	5.100e-01	4.189e-04	9.936e-04
0.5	1.320e+06	1.030e-01	2.204e-01	2.021e-04	4.327e-04
0.6	3.560e+11	3.529e+04	6.995e+04	6.888e+01	1.365e+02
0.8	2.148e+08	3.104e+01	5.502e+01	5.904e-02	1.047e-01
1.0	4.552e+09	8.801e+02	1.453e+03	1.622e+00	2.678e+00

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<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
1.5	4.594e+09	1.499e+03	2.208e+03	2.523e+00	3.714e+00
TOTALS:	3.945e+11	3.772e+04	7.373e+04	7.320e+01	1.434e+02

Results - Dose Point # 4 - (305.8,486,45.72) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	8.603e+00	2.004e+01	8.526e-02	1.986e-01
0.04	5.603e+09	5.757e+00	2.087e+01	2.546e-02	9.229e-02
0.05	2.678e+07	5.424e-02	2.744e-01	1.445e-04	7.308e-04
0.1	2.096e+08	1.810e+00	1.022e+01	2.769e-03	1.563e-02
0.2	3.538e+07	8.109e-01	2.835e+00	1.431e-03	5.004e-03
0.3	4.807e+03	1.883e-04	5.165e-04	3.571e-07	9.797e-07
0.4	3.696e+06	2.113e-01	4.995e-01	4.117e-04	9.733e-04
0.5	1.320e+06	1.012e-01	2.159e-01	1.986e-04	4.239e-04
0.6	3.560e+11	3.467e+04	6.852e+04	6.767e+01	1.337e+02
0.8	2.148e+08	3.048e+01	5.389e+01	5.798e-02	1.025e-01
1.0	4.552e+09	8.640e+02	1.423e+03	1.593e+00	2.623e+00
1.5	4.594e+09	1.471e+03	2.162e+03	2.475e+00	3.637e+00
TOTALS:	3.945e+11	3.705e+04	7.221e+04	7.191e+01	1.404e+02

Results - Dose Point # 5 - (305.8,394,45.72) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	8.376e+00	1.951e+01	8.301e-02	1.933e-01
0.04	5.603e+09	5.604e+00	2.030e+01	2.479e-02	8.979e-02
0.05	2.678e+07	5.279e-02	2.669e-01	1.406e-04	7.110e-04
0.1	2.096e+08	1.760e+00	9.894e+00	2.693e-03	1.514e-02
0.2	3.538e+07	7.880e-01	2.741e+00	1.391e-03	4.837e-03
0.3	4.807e+03	1.828e-04	4.992e-04	3.468e-07	9.469e-07
0.4	3.696e+06	2.051e-01	4.828e-01	3.997e-04	9.406e-04
0.5	1.320e+06	9.820e-02	2.087e-01	1.928e-04	4.096e-04
0.6	3.560e+11	3.363e+04	6.622e+04	6.564e+01	1.293e+02
0.8	2.148e+08	2.956e+01	5.208e+01	5.622e-02	9.907e-02
1.0	4.552e+09	8.374e+02	1.375e+03	1.544e+00	2.535e+00
1.5	4.594e+09	1.425e+03	2.089e+03	2.397e+00	3.515e+00
TOTALS:	3.945e+11	3.594e+04	6.979e+04	6.975e+01	1.357e+02

Results - Dose Point # 6 - (305.8,302,45.72) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	7.996e+00	1.862e+01	7.925e-02	1.845e-01
0.04	5.603e+09	5.349e+00	1.937e+01	2.366e-02	8.565e-02
0.05	2.678e+07	5.037e-02	2.545e-01	1.342e-04	6.781e-04
0.1	2.096e+08	1.678e+00	9.383e+00	2.567e-03	1.436e-02

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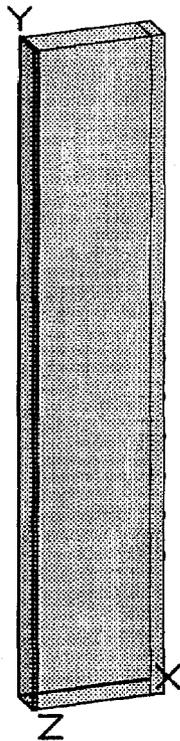
<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.2	3.538e+07	7.504e-01	2.595e+00	1.324e-03	4.580e-03
0.3	4.807e+03	1.740e-04	4.726e-04	3.300e-07	8.965e-07
0.4	3.696e+06	1.951e-01	4.571e-01	3.802e-04	8.907e-04
0.5	1.320e+06	9.337e-02	1.976e-01	1.833e-04	3.879e-04
0.6	3.560e+11	3.197e+04	6.272e+04	6.240e+01	1.224e+02
0.8	2.148e+08	2.808e+01	4.933e+01	5.341e-02	9.384e-02
1.0	4.552e+09	7.953e+02	1.303e+03	1.466e+00	2.401e+00
1.5	4.594e+09	1.352e+03	1.980e+03	2.275e+00	3.331e+00
TOTALS:	3.945e+11	3.416e+04	6.610e+04	6.630e+01	1.285e+02

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company

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File Ref: _____
 Date: _____
 By:
 Checked: 5/12/03

Case Title: Tank 709
 Description: Rad field from sediment shielded with 1 ft soil
 Geometry: 13 - Rectangular Volume



Source Dimensions

Length	9.86 cm	3.9 in
Width	91.44 cm	3 ft
Height	1.5e+3 cm	50 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	305.8 cm	762 cm	45.72 cm
	10 ft 0.4 in	25 ft 1 ft 6.0 in	
# 2	305.8 cm	670 cm	45.72 cm
	10 ft 0.4 in	21 ft 11.8 in	1 ft 6.0 in
# 3	305.8 cm	578 cm	45.72 cm
	10 ft 0.4 in	18 ft 11.6 in	1 ft 6.0 in
# 4	305.8 cm	486 cm	45.72 cm
	10 ft 0.4 in	15 ft 11.3 in	1 ft 6.0 in
# 5	305.8 cm	394 cm	45.72 cm
	10 ft 0.4 in	12 ft 11.1 in	1 ft 6.0 in
# 6	305.8 cm	302 cm	45.72 cm
	10 ft 0.4 in	9 ft 10.9 in	1 ft 6.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.37e+06 cm ³	Concrete	2
Shield 1	264.46 cm	Air	0.0011
Shield 2	30.48 cm	Concrete	1.8
Shield 3	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : Grove

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup

The material reference is : Shield 2

Integration Parameters

X Direction	10
Y Direction	20

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Z Direction

20

Results - Dose Point # 1 - (305.8,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	7.568e-28	4.878e-24	7.500e-30	4.834e-26
0.04	5.603e+09	3.618e-14	1.388e-13	1.600e-16	6.140e-16
0.05	2.678e+07	3.039e-11	2.067e-10	8.097e-14	5.506e-13
0.1	2.096e+08	6.304e-05	1.777e-03	9.645e-08	2.718e-06
0.2	3.538e+07	3.821e-04	1.317e-02	6.745e-07	2.325e-05
0.3	4.807e+03	2.473e-07	6.488e-06	4.691e-10	1.231e-08
0.4	3.696e+06	5.417e-04	1.071e-02	1.055e-06	2.086e-05
0.5	1.320e+06	4.249e-04	6.590e-03	8.341e-07	1.293e-05
0.6	3.560e+11	2.142e+02	2.707e+03	4.182e-01	5.283e+00
0.8	2.148e+08	3.370e-01	3.095e+00	6.409e-04	5.886e-03
1.0	4.552e+09	1.463e+01	1.057e+02	2.696e-02	1.948e-01
1.5	4.594e+09	5.061e+01	2.453e+02	8.515e-02	4.127e-01
TOTALS:	3.945e+11	2.798e+02	3.061e+03	5.309e-01	5.896e+00

Results - Dose Point # 2 - (305.8,670,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	7.561e-28	4.860e-24	7.493e-30	4.816e-26
0.04	5.603e+09	3.618e-14	1.388e-13	1.600e-16	6.140e-16
0.05	2.678e+07	3.040e-11	2.067e-10	8.097e-14	5.506e-13
0.1	2.096e+08	6.304e-05	1.777e-03	9.645e-08	2.718e-06
0.2	3.538e+07	3.821e-04	1.317e-02	6.745e-07	2.325e-05
0.3	4.807e+03	2.473e-07	6.488e-06	4.691e-10	1.231e-08
0.4	3.696e+06	5.417e-04	1.071e-02	1.055e-06	2.086e-05
0.5	1.320e+06	4.249e-04	6.589e-03	8.341e-07	1.293e-05
0.6	3.560e+11	2.142e+02	2.706e+03	4.182e-01	5.283e+00
0.8	2.148e+08	3.370e-01	3.094e+00	6.409e-04	5.886e-03
1.0	4.552e+09	1.463e+01	1.056e+02	2.696e-02	1.947e-01
1.5	4.594e+09	5.060e+01	2.452e+02	8.513e-02	4.125e-01
TOTALS:	3.945e+11	2.798e+02	3.060e+03	5.309e-01	5.896e+00

Results - Dose Point # 3 - (305.8,578,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	7.542e-28	4.804e-24	7.474e-30	4.762e-26
0.04	5.603e+09	3.619e-14	1.389e-13	1.601e-16	6.142e-16
0.05	2.678e+07	3.040e-11	2.067e-10	8.098e-14	5.507e-13
0.1	2.096e+08	6.304e-05	1.777e-03	9.645e-08	2.718e-06
0.2	3.538e+07	3.821e-04	1.317e-02	6.745e-07	2.324e-05
0.3	4.807e+03	2.473e-07	6.487e-06	4.691e-10	1.231e-08
0.4	3.696e+06	5.416e-04	1.071e-02	1.055e-06	2.086e-05
0.5	1.320e+06	4.249e-04	6.588e-03	8.340e-07	1.293e-05
0.6	3.560e+11	2.142e+02	2.706e+03	4.181e-01	5.281e+00

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 Duration: 00:01:44

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.8	2.148e+08	3.369e-01	3.093e+00	6.408e-04	5.883e-03
1.0	4.552e+09	1.462e+01	1.056e+02	2.695e-02	1.946e-01
1.5	4.594e+09	5.056e+01	2.448e+02	8.507e-02	4.119e-01
TOTALS:	3.945e+11	2.797e+02	3.059e+03	5.308e-01	5.894e+00

Results - Dose Point # 4 - (305.8,486,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	7.557e-28	4.705e-24	7.490e-30	4.663e-26
0.04	5.603e+09	3.617e-14	1.388e-13	1.600e-16	6.138e-16
0.05	2.678e+07	3.040e-11	2.067e-10	8.098e-14	5.507e-13
0.1	2.096e+08	6.304e-05	1.777e-03	9.645e-08	2.718e-06
0.2	3.538e+07	3.821e-04	1.317e-02	6.744e-07	2.324e-05
0.3	4.807e+03	2.473e-07	6.485e-06	4.691e-10	1.230e-08
0.4	3.696e+06	5.415e-04	1.070e-02	1.055e-06	2.085e-05
0.5	1.320e+06	4.248e-04	6.583e-03	8.338e-07	1.292e-05
0.6	3.560e+11	2.141e+02	2.703e+03	4.179e-01	5.275e+00
0.8	2.148e+08	3.366e-01	3.087e+00	6.403e-04	5.872e-03
1.0	4.552e+09	1.460e+01	1.053e+02	2.692e-02	1.941e-01
1.5	4.594e+09	5.045e+01	2.438e+02	8.488e-02	4.102e-01
TOTALS:	3.945e+11	2.795e+02	3.055e+03	5.304e-01	5.885e+00

Results - Dose Point # 5 - (305.8,394,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	7.550e-28	4.550e-24	7.483e-30	4.509e-26
0.04	5.603e+09	3.616e-14	1.388e-13	1.599e-16	6.137e-16
0.05	2.678e+07	3.040e-11	2.067e-10	8.098e-14	5.507e-13
0.1	2.096e+08	6.304e-05	1.776e-03	9.644e-08	2.718e-06
0.2	3.538e+07	3.820e-04	1.316e-02	6.742e-07	2.322e-05
0.3	4.807e+03	2.471e-07	6.473e-06	4.687e-10	1.228e-08
0.4	3.696e+06	5.409e-04	1.067e-02	1.054e-06	2.079e-05
0.5	1.320e+06	4.240e-04	6.559e-03	8.323e-07	1.287e-05
0.6	3.560e+11	2.136e+02	2.691e+03	4.170e-01	5.252e+00
0.8	2.148e+08	3.355e-01	3.069e+00	6.382e-04	5.837e-03
1.0	4.552e+09	1.454e+01	1.045e+02	2.680e-02	1.926e-01
1.5	4.594e+09	5.010e+01	2.412e+02	8.430e-02	4.058e-01
TOTALS:	3.945e+11	2.786e+02	3.039e+03	5.287e-01	5.856e+00

Results - Dose Point # 6 - (305.8,302,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	7.543e-28	4.320e-24	7.476e-30	4.281e-26
0.04	5.603e+09	3.616e-14	1.388e-13	1.599e-16	6.137e-16

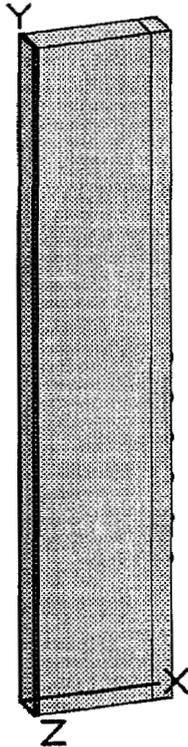
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 Duration: 00:01:44

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
0.05	2.678e+07	3.040e-11	2.067e-10	8.098e-14	5.507e-13
0.1	2.096e+08	6.298e-05	1.773e-03	9.635e-08	2.713e-06
0.2	3.538e+07	3.808e-04	1.308e-02	6.720e-07	2.309e-05
0.3	4.807e+03	2.459e-07	6.415e-06	4.664e-10	1.217e-08
0.4	3.696e+06	5.372e-04	1.055e-02	1.047e-06	2.055e-05
0.5	1.320e+06	4.205e-04	6.469e-03	8.254e-07	1.270e-05
0.6	3.560e+11	2.115e+02	2.648e+03	4.129e-01	5.169e+00
0.8	2.148e+08	3.313e-01	3.010e+00	6.301e-04	5.724e-03
1.0	4.552e+09	1.432e+01	1.022e+02	2.640e-02	1.884e-01
1.5	4.594e+09	4.908e+01	2.345e+02	8.258e-02	3.946e-01
TOTALS:	3.945e+11	2.753e+02	2.988e+03	5.225e-01	5.758e+00

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 Run Time: 9:56:26 PM
 Duration: 00:01:46

File Ref: _____
 Date: _____
 By: DM
 Checked: 5/12/03

Case Title: Tank 709
 Description: Rad field from sediment shielded with 18 " soil
 Geometry: 13 - Rectangular Volume



Source Dimensions

Length	9.86 cm	3.9 in
Width	91.44 cm	3 ft
Height	1.5e+3 cm	50 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	321.04 cm	762 cm	45.72 cm
	10 ft 6.4 in	25 ft 1 ft 6.0 in	
# 2	321.04 cm	670 cm	45.72 cm
	10 ft 6.4 in	21 ft 11.8 in	1 ft 6.0 in
# 3	321.04 cm	578 cm	45.72 cm
	10 ft 6.4 in	18 ft 11.6 in	1 ft 6.0 in
# 4	321.04 cm	486 cm	45.72 cm
	10 ft 6.4 in	15 ft 11.3 in	1 ft 6.0 in
# 5	321.04 cm	394 cm	45.72 cm
	10 ft 6.4 in	12 ft 11.1 in	1 ft 6.0 in
# 6	321.04 cm	302 cm	45.72 cm
	10 ft 6.4 in	9 ft 10.9 in	1 ft 6.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.37e+06 cm ³	Concrete	2
Shield 1	264.46 cm	Air	0.0011
Shield 2	45.72 cm	Concrete	1.8
Shield 3	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input

Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded
 Library : Grove

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup

The material reference is : Shield 2

Integration Parameters

X Direction	10
Y Direction	20

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Z Direction

20

Results - Dose Point # 1 - (321.04,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	1.359e-41	4.578e-24	1.346e-43	4.537e-26
0.04	5.603e+09	4.650e-21	1.897e-20	2.057e-23	8.391e-23
0.05	2.678e+07	1.052e-15	8.859e-15	2.804e-18	2.360e-17
0.1	2.096e+08	4.681e-07	2.193e-05	7.161e-10	3.354e-08
0.2	3.538e+07	9.929e-06	6.502e-04	1.752e-08	1.147e-06
0.3	4.807e+03	1.049e-08	5.119e-07	1.990e-11	9.711e-10
0.4	3.696e+06	3.160e-05	1.116e-03	6.156e-08	2.175e-06
0.5	1.320e+06	3.133e-05	8.349e-04	6.150e-08	1.639e-06
0.6	3.560e+11	1.897e+01	3.987e+02	3.702e-02	7.783e-01
0.8	2.148e+08	3.925e-02	5.672e-01	7.465e-05	1.079e-03
1.0	4.552e+09	2.081e+00	2.262e+01	3.835e-03	4.169e-02
1.5	4.594e+09	1.002e+01	6.810e+01	1.686e-02	1.146e-01
TOTALS:	3.945e+11	3.111e+01	4.900e+02	5.779e-02	9.356e-01

Results - Dose Point # 2 - (321.04,670,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	1.357e-41	4.560e-24	1.345e-43	4.520e-26
0.04	5.603e+09	4.649e-21	1.897e-20	2.056e-23	8.389e-23
0.05	2.678e+07	1.053e-15	8.860e-15	2.804e-18	2.360e-17
0.1	2.096e+08	4.681e-07	2.193e-05	7.161e-10	3.354e-08
0.2	3.538e+07	9.929e-06	6.501e-04	1.752e-08	1.147e-06
0.3	4.807e+03	1.049e-08	5.119e-07	1.990e-11	9.711e-10
0.4	3.696e+06	3.160e-05	1.116e-03	6.156e-08	2.175e-06
0.5	1.320e+06	3.133e-05	8.349e-04	6.150e-08	1.639e-06
0.6	3.560e+11	1.897e+01	3.987e+02	3.702e-02	7.783e-01
0.8	2.148e+08	3.925e-02	5.672e-01	7.465e-05	1.079e-03
1.0	4.552e+09	2.081e+00	2.262e+01	3.835e-03	4.169e-02
1.5	4.594e+09	1.002e+01	6.809e+01	1.686e-02	1.146e-01
TOTALS:	3.945e+11	3.111e+01	4.900e+02	5.779e-02	9.356e-01

Results - Dose Point # 3 - (321.04,578,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	1.355e-41	4.507e-24	1.343e-43	4.466e-26
0.04	5.603e+09	4.646e-21	1.896e-20	2.055e-23	8.383e-23
0.05	2.678e+07	1.053e-15	8.863e-15	2.805e-18	2.361e-17
0.1	2.096e+08	4.681e-07	2.192e-05	7.161e-10	3.354e-08
0.2	3.538e+07	9.929e-06	6.501e-04	1.752e-08	1.147e-06
0.3	4.807e+03	1.049e-08	5.119e-07	1.990e-11	9.711e-10
0.4	3.696e+06	3.160e-05	1.116e-03	6.156e-08	2.175e-06
0.5	1.320e+06	3.133e-05	8.349e-04	6.150e-08	1.639e-06
0.6	3.560e+11	1.897e+01	3.987e+02	3.702e-02	7.783e-01

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<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.8	2.148e+08	3.924e-02	5.671e-01	7.465e-05	1.079e-03
1.0	4.552e+09	2.081e+00	2.261e+01	3.835e-03	4.169e-02
1.5	4.594e+09	1.002e+01	6.806e+01	1.685e-02	1.145e-01
TOTALS:	3.945e+11	3.110e+01	4.900e+02	5.778e-02	9.355e-01

Results - Dose Point # 4 - (321.04,486,45.72) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	1.366e-41	4.410e-24	1.354e-43	4.371e-26
0.04	5.603e+09	4.641e-21	1.894e-20	2.053e-23	8.375e-23
0.05	2.678e+07	1.052e-15	8.859e-15	2.804e-18	2.360e-17
0.1	2.096e+08	4.681e-07	2.193e-05	7.161e-10	3.354e-08
0.2	3.538e+07	9.929e-06	6.501e-04	1.752e-08	1.147e-06
0.3	4.807e+03	1.049e-08	5.119e-07	1.990e-11	9.710e-10
0.4	3.696e+06	3.159e-05	1.116e-03	6.156e-08	2.175e-06
0.5	1.320e+06	3.133e-05	8.347e-04	6.150e-08	1.638e-06
0.6	3.560e+11	1.897e+01	3.986e+02	3.702e-02	7.780e-01
0.8	2.148e+08	3.924e-02	5.668e-01	7.463e-05	1.078e-03
1.0	4.552e+09	2.080e+00	2.260e+01	3.834e-03	4.165e-02
1.5	4.594e+09	1.001e+01	6.795e+01	1.684e-02	1.143e-01
TOTALS:	3.945e+11	3.109e+01	4.897e+02	5.776e-02	9.351e-01

Results - Dose Point # 5 - (321.04,394,45.72) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	1.370e-41	4.261e-24	1.357e-43	4.223e-26
0.04	5.603e+09	4.638e-21	1.892e-20	2.051e-23	8.368e-23
0.05	2.678e+07	1.052e-15	8.859e-15	2.804e-18	2.360e-17
0.1	2.096e+08	4.681e-07	2.193e-05	7.161e-10	3.354e-08
0.2	3.538e+07	9.928e-06	6.500e-04	1.752e-08	1.147e-06
0.3	4.807e+03	1.049e-08	5.117e-07	1.990e-11	9.706e-10
0.4	3.696e+06	3.158e-05	1.115e-03	6.154e-08	2.173e-06
0.5	1.320e+06	3.131e-05	8.337e-04	6.147e-08	1.637e-06
0.6	3.560e+11	1.895e+01	3.980e+02	3.699e-02	7.768e-01
0.8	2.148e+08	3.919e-02	5.654e-01	7.453e-05	1.075e-03
1.0	4.552e+09	2.076e+00	2.252e+01	3.826e-03	4.151e-02
1.5	4.594e+09	9.972e+00	6.755e+01	1.678e-02	1.136e-01
TOTALS:	3.945e+11	3.104e+01	4.886e+02	5.767e-02	9.331e-01

Results - Dose Point # 6 - (321.04,302,45.72) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	1.367e-41	4.043e-24	1.355e-43	4.006e-2
0.04	5.603e+09	4.638e-21	1.892e-20	2.051e-23	8.369e-2

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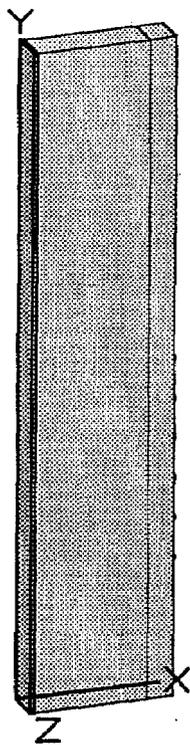
<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.05	2.678e+07	1.052e-15	8.859e-15	2.804e-18	2.360e-17
0.1	2.096e+08	4.680e-07	2.192e-05	7.159e-10	3.353e-08
0.2	3.538e+07	9.918e-06	6.487e-04	1.750e-08	1.145e-06
0.3	4.807e+03	1.047e-08	5.098e-07	1.986e-11	9.670e-10
0.4	3.696e+06	3.149e-05	1.109e-03	6.136e-08	2.161e-06
0.5	1.320e+06	3.119e-05	8.280e-04	6.122e-08	1.625e-06
0.6	3.560e+11	1.886e+01	3.947e+02	3.680e-02	7.703e-01
0.8	2.148e+08	3.891e-02	5.591e-01	7.400e-05	1.063e-03
1.0	4.552e+09	2.057e+00	2.221e+01	3.791e-03	4.094e-02
1.5	4.594e+09	9.835e+00	6.626e+01	1.655e-02	1.115e-01
TOTALS:	3.945e+11	3.079e+01	4.837e+02	5.722e-02	9.238e-01

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company

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File Ref: _____
 Date: _____
 By: *AKW*
 Checked: *5/12/03*

Case Title: Tank 709
 Description: Rad field from sediment shielded with **24 " soil**
 Geometry: 13 - Rectangular Volume



Source Dimensions

Length	9.86 cm	3.9 in
Width	91.44 cm	3 ft
Height	1.5e+3 cm	50 ft

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	336.28 cm	762 cm	45.72 cm
	11 ft 0.4 in	25 ft	1 ft 6.0 in
# 2	336.28 cm	670 cm	45.72 cm
	11 ft 0.4 in	21 ft 11.8 in	1 ft 6.0 in
# 3	336.28 cm	578 cm	45.72 cm
	11 ft 0.4 in	18 ft 11.6 in	1 ft 6.0 in
# 4	336.28 cm	486 cm	45.72 cm
	11 ft 0.4 in	15 ft 11.3 in	1 ft 6.0 in
# 5	336.28 cm	394 cm	45.72 cm
	11 ft 0.4 in	12 ft 11.1 in	1 ft 6.0 in
# 6	336.28 cm	302 cm	45.72 cm
	11 ft 0.4 in	9 ft 10.9 in	1 ft 6.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.37e+06 cm ³	Concrete	2
Shield 1	264.46 cm	Air	0.0011
Shield 2	60.96 cm	Concrete	1.8
Shield 3	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Library : Grove

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup
 The material reference is : Shield 2

Integration Parameters

X Direction	10
Y Direction	20

Z Direction

20

Results - Dose Point # 1 - (336.28,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	2.625e-55	4.306e-24	2.602e-57	4.267e-26
0.04	5.603e+09	6.368e-28	2.746e-24	2.816e-30	1.215e-26
0.05	2.678e+07	3.866e-20	3.709e-19	1.030e-22	9.880e-22
0.1	2.096e+08	3.652e-09	2.548e-07	5.587e-12	3.898e-10
0.2	3.538e+07	2.701e-07	2.960e-05	4.768e-10	5.224e-08
0.3	4.807e+03	4.653e-10	3.735e-08	8.826e-13	7.085e-11
0.4	3.696e+06	1.924e-06	1.082e-04	3.749e-09	2.108e-07
0.5	1.320e+06	2.410e-06	9.913e-05	4.730e-09	1.946e-07
0.6	3.560e+11	1.750e+00	5.530e+01	3.416e-03	1.079e-01
0.8	2.148e+08	4.756e-03	9.909e-02	9.046e-06	1.885e-04
1.0	4.552e+09	3.076e-01	4.654e+00	5.670e-04	8.578e-03
1.5	4.594e+09	2.056e+00	1.836e+01	3.460e-03	3.089e-02
TOTALS:	3.945e+11	4.119e+00	7.841e+01	7.452e-03	1.476e-01

Results - Dose Point # 2 - (336.28,670,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	2.625e-55	4.289e-24	2.601e-57	4.251e-26
0.04	5.603e+09	6.365e-28	2.736e-24	2.815e-30	1.210e-26
0.05	2.678e+07	3.866e-20	3.709e-19	1.030e-22	9.881e-22
0.1	2.096e+08	3.652e-09	2.548e-07	5.587e-12	3.898e-10
0.2	3.538e+07	2.701e-07	2.960e-05	4.768e-10	5.224e-08
0.3	4.807e+03	4.653e-10	3.735e-08	8.826e-13	7.085e-11
0.4	3.696e+06	1.924e-06	1.082e-04	3.749e-09	2.108e-07
0.5	1.320e+06	2.410e-06	9.913e-05	4.730e-09	1.946e-07
0.6	3.560e+11	1.750e+00	5.530e+01	3.416e-03	1.079e-01
0.8	2.148e+08	4.756e-03	9.909e-02	9.046e-06	1.885e-04
1.0	4.552e+09	3.076e-01	4.654e+00	5.670e-04	8.578e-03
1.5	4.594e+09	2.056e+00	1.836e+01	3.460e-03	3.089e-02
TOTALS:	3.945e+11	4.119e+00	7.841e+01	7.452e-03	1.476e-01

Results - Dose Point # 3 - (336.28,578,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	2.625e-55	4.237e-24	2.602e-57	4.199e-26
0.04	5.603e+09	6.354e-28	2.702e-24	2.810e-30	1.195e-26
0.05	2.678e+07	3.867e-20	3.710e-19	1.030e-22	9.883e-22
0.1	2.096e+08	3.652e-09	2.548e-07	5.587e-12	3.898e-10
0.2	3.538e+07	2.701e-07	2.960e-05	4.768e-10	5.224e-08
0.3	4.807e+03	4.653e-10	3.735e-08	8.826e-13	7.085e-11
0.4	3.696e+06	1.924e-06	1.082e-04	3.749e-09	2.108e-07
0.5	1.320e+06	2.410e-06	9.913e-05	4.730e-09	1.946e-07
0.6	3.560e+11	1.750e+00	5.530e+01	3.416e-03	1.079e-01

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Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.8	2.148e+08	4.756e-03	9.909e-02	9.046e-06	1.885e-04
1.0	4.552e+09	3.076e-01	4.653e+00	5.670e-04	8.577e-03
1.5	4.594e+09	2.056e+00	1.836e+01	3.460e-03	3.089e-02
TOTALS:	3.945e+11	4.119e+00	7.841e+01	7.451e-03	1.476e-01

Results - Dose Point # 4 - (336.28,486,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	2.658e-55	4.144e-24	2.634e-57	4.107e-26
0.04	5.603e+09	6.352e-28	2.643e-24	2.809e-30	1.169e-26
0.05	2.678e+07	3.864e-20	3.707e-19	1.029e-22	9.875e-22
0.1	2.096e+08	3.652e-09	2.548e-07	5.587e-12	3.899e-10
0.2	3.538e+07	2.701e-07	2.960e-05	4.768e-10	5.224e-08
0.3	4.807e+03	4.653e-10	3.735e-08	8.826e-13	7.085e-11
0.4	3.696e+06	1.924e-06	1.082e-04	3.749e-09	2.108e-07
0.5	1.320e+06	2.410e-06	9.913e-05	4.730e-09	1.946e-07
0.6	3.560e+11	1.750e+00	5.529e+01	3.415e-03	1.079e-01
0.8	2.148e+08	4.756e-03	9.907e-02	9.046e-06	1.884e-04
1.0	4.552e+09	3.076e-01	4.652e+00	5.669e-04	8.575e-03
1.5	4.594e+09	2.055e+00	1.835e+01	3.458e-03	3.087e-02
TOTALS:	3.945e+11	4.118e+00	7.839e+01	7.450e-03	1.476e-01

Results - Dose Point # 5 - (336.28,394,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	2.675e-55	4.001e-24	2.651e-57	3.965e-26
0.04	5.603e+09	6.344e-28	2.552e-24	2.806e-30	1.129e-26
0.05	2.678e+07	3.863e-20	3.706e-19	1.029e-22	9.874e-22
0.1	2.096e+08	3.652e-09	2.548e-07	5.587e-12	3.899e-10
0.2	3.538e+07	2.701e-07	2.960e-05	4.768e-10	5.224e-08
0.3	4.807e+03	4.653e-10	3.734e-08	8.826e-13	7.084e-11
0.4	3.696e+06	1.924e-06	1.081e-04	3.749e-09	2.107e-07
0.5	1.320e+06	2.409e-06	9.908e-05	4.729e-09	1.945e-07
0.6	3.560e+11	1.749e+00	5.526e+01	3.414e-03	1.079e-01
0.8	2.148e+08	4.753e-03	9.896e-02	9.040e-06	1.882e-04
1.0	4.552e+09	3.073e-01	4.644e+00	5.664e-04	8.560e-03
1.5	4.594e+09	2.051e+00	1.828e+01	3.451e-03	3.076e-02
TOTALS:	3.945e+11	4.113e+00	7.828e+01	7.441e-03	1.474e-01

Results - Dose Point # 6 - (336.28,302,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	2.672e-55	3.793e-24	2.648e-57	3.759e-26
0.04	5.603e+09	6.343e-28	2.419e-24	2.805e-30	1.070e-26

Page : 4
 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 10:04:57 PM
 Duration: 00:01:47

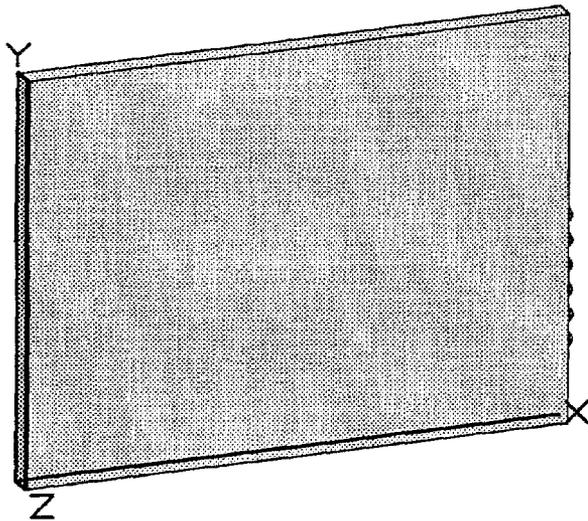
Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>mR/hr</u> <u>No Buildup</u>	<u>mR/hr</u> <u>With Buildup</u>
0.05	2.678e+07	3.863e-20	3.707e-19	1.029e-22	9.874e-22
0.1	2.096e+08	3.652e-09	2.548e-07	5.587e-12	3.898e-10
0.2	3.538e+07	2.700e-07	2.957e-05	4.766e-10	5.220e-08
0.3	4.807e+03	4.649e-10	3.728e-08	8.818e-13	7.072e-11
0.4	3.696e+06	1.921e-06	1.078e-04	3.743e-09	2.101e-07
0.5	1.320e+06	2.404e-06	9.871e-05	4.719e-09	1.938e-07
0.6	3.560e+11	1.744e+00	5.499e+01	3.405e-03	1.073e-01
0.8	2.148e+08	4.732e-03	9.828e-02	9.001e-06	1.869e-04
1.0	4.552e+09	3.054e-01	4.602e+00	5.630e-04	8.483e-03
1.5	4.594e+09	2.031e+00	1.803e+01	3.417e-03	3.034e-02
TOTALS:	3.945e+11	4.086e+00	7.773e+01	7.394e-03	1.463e-01

Page : 1
 DOS File: PM2A709.MS5
 Run Date: November 30, 2003
 Run Time: 9:56:41 PM
 Duration: 00:01:39

File Ref: _____
 Date: 01-13-04
 By: *D. Anderson*
 Checked: _____

Case Title: Tank 709
 Description: Rad field from 709 tank sediment at edge of pit (66')
 Geometry: 13 - Rectangular Volume

Source Dimensions			
Length	9.86 cm	3.9 in	
Width	91.44 cm	3 ft	
Height	1.5e+3 cm	50 ft	



Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	2021.86 cm	762 cm	45.72 cm
	66 ft 4.0 in	25 ft	1 ft 6.0 in
# 2	2021.86 cm	670 cm	45.72 cm
	66 ft 4.0 in	21 ft 11.8 in	1 ft 6.0 in
# 3	2021.86 cm	578 cm	45.72 cm
	66 ft 4.0 in	18 ft 11.6 in	1 ft 6.0 in
# 4	2021.86 cm	486 cm	45.72 cm
	66 ft 4.0 in	15 ft 11.3 in	1 ft 6.0 in
# 5	2021.86 cm	394 cm	45.72 cm
	66 ft 4.0 in	12 ft 11.1 in	1 ft 6.0 in
# 6	2021.86 cm	302 cm	45.72 cm
	66 ft 4.0 in	9 ft 10.9 in	1 ft 6.0 in

Shields			
Shield Name	Dimension	Material	Density
Source	1.37e+06 cm ³	Concrete 2	
Shield 1	2012.0 cm	Air	0.0011
Air Gap		Air	0.0011

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Library : Grove				
Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup
 The material reference is : Shield 1

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Page : 2
 DOS File: PM2A709.MS5
 Run Date: November 30, 2003
 Run Time: 9:56:41 PM
 Duration: 00:01:39

Results - Dose Point # 1 - (2021.86,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	2.735e-01	8.010e-01	2.710e-03	7.939e-03
0.04	5.603e+09	2.177e-01	1.028e+00	9.630e-04	4.547e-03
0.05	2.678e+07	2.189e-03	1.440e-02	5.831e-06	3.837e-05
0.1	2.096e+08	7.875e-02	5.376e-01	1.205e-04	8.225e-04
0.2	3.538e+07	3.668e-02	1.436e-01	6.474e-05	2.535e-04
0.3	4.807e+03	8.694e-06	2.581e-05	1.649e-08	4.896e-08
0.4	3.696e+06	9.885e-03	2.478e-02	1.926e-05	4.828e-05
0.5	1.320e+06	4.776e-03	1.066e-02	9.374e-06	2.093e-05
0.6	3.560e+11	1.646e+03	3.371e+03	3.213e+00	6.579e+00
0.8	2.148e+08	1.459e+00	2.637e+00	2.776e-03	5.017e-03
1.0	4.552e+09	4.156e+01	6.946e+01	7.661e-02	1.280e-01
1.5	4.594e+09	7.116e+01	1.050e+02	1.197e-01	1.767e-01
TOTALS:	3.945e+11	1.761e+03	3.550e+03	3.416e+00	6.903e+00

Results - Dose Point # 2 - (2021.86,670,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	2.727e-01	7.988e-01	2.702e-03	7.917e-03
0.04	5.603e+09	2.171e-01	1.026e+00	9.604e-04	4.536e-03
0.05	2.678e+07	2.183e-03	1.437e-02	5.815e-06	3.827e-05
0.1	2.096e+08	7.855e-02	5.365e-01	1.202e-04	8.208e-04
0.2	3.538e+07	3.659e-02	1.434e-01	6.458e-05	2.531e-04
0.3	4.807e+03	8.674e-06	2.576e-05	1.645e-08	4.887e-08
0.4	3.696e+06	9.862e-03	2.473e-02	1.922e-05	4.819e-05
0.5	1.320e+06	4.765e-03	1.064e-02	9.353e-06	2.089e-05
0.6	3.560e+11	1.643e+03	3.364e+03	3.206e+00	6.567e+00
0.8	2.148e+08	1.456e+00	2.633e+00	2.769e-03	5.007e-03
1.0	4.552e+09	4.147e+01	6.933e+01	7.644e-02	1.278e-01
1.5	4.594e+09	7.102e+01	1.048e+02	1.195e-01	1.763e-01
TOTALS:	3.945e+11	1.757e+03	3.544e+03	3.409e+00	6.890e+00

Results - Dose Point # 3 - (2021.86,578,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	2.703e-01	7.923e-01	2.679e-03	7.852e-03
0.04	5.603e+09	2.154e-01	1.018e+00	9.524e-04	4.501e-03
0.05	2.678e+07	2.165e-03	1.426e-02	5.768e-06	3.799e-05
0.1	2.096e+08	7.795e-02	5.332e-01	1.193e-04	8.158e-04
0.2	3.538e+07	3.632e-02	1.426e-01	6.411e-05	2.516e-04
0.3	4.807e+03	8.612e-06	2.562e-05	1.634e-08	4.859e-08
0.4	3.696e+06	9.794e-03	2.459e-02	1.908e-05	4.792e-05
0.5	1.320e+06	4.732e-03	1.058e-02	9.288e-06	2.077e-05
0.6	3.560e+11	1.631e+03	3.345e+03	3.184e+00	6.530e+00
0.8	2.148e+08	1.446e+00	2.618e+00	2.751e-03	4.979e-03
1.0	4.552e+09	4.120e+01	6.895e+01	7.595e-02	1.271e-01

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 DOS File: PM2A709.MS5
 Run Date: November 30, 2003
 Run Time: 9:56:41 PM
 Duration: 00:01:39

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
1.5	4.594e+09	7.057e+01	1.042e+02	1.187e-01	1.754e-01
TOTALS:	3.945e+11	1.745e+03	3.524e+03	3.386e+00	6.851e+00

Results - Dose Point # 4 - (2021.86,486,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	2.664e-01	7.815e-01	2.640e-03	7.746e-03
0.04	5.603e+09	2.124e-01	1.005e+00	9.394e-04	4.444e-03
0.05	2.678e+07	2.136e-03	1.409e-02	5.691e-06	3.752e-05
0.1	2.096e+08	7.696e-02	5.278e-01	1.177e-04	8.075e-04
0.2	3.538e+07	3.588e-02	1.412e-01	6.333e-05	2.493e-04
0.3	4.807e+03	8.510e-06	2.538e-05	1.614e-08	4.814e-08
0.4	3.696e+06	9.681e-03	2.436e-02	1.886e-05	4.747e-05
0.5	1.320e+06	4.678e-03	1.048e-02	9.183e-06	2.058e-05
0.6	3.560e+11	1.613e+03	3.314e+03	3.149e+00	6.469e+00
0.8	2.148e+08	1.431e+00	2.594e+00	2.721e-03	4.933e-03
1.0	4.552e+09	4.076e+01	6.831e+01	7.514e-02	1.259e-01
1.5	4.594e+09	6.984e+01	1.033e+02	1.175e-01	1.738e-01
TOTALS:	3.945e+11	1.726e+03	3.491e+03	3.348e+00	6.787e+00

Results - Dose Point # 5 - (2021.86,394,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	2.611e-01	7.668e-01	2.587e-03	7.599e-03
0.04	5.603e+09	2.084e-01	9.870e-01	9.215e-04	4.365e-03
0.05	2.678e+07	2.097e-03	1.385e-02	5.585e-06	3.688e-05
0.1	2.096e+08	7.560e-02	5.204e-01	1.157e-04	7.962e-04
0.2	3.538e+07	3.528e-02	1.394e-01	6.226e-05	2.460e-04
0.3	4.807e+03	8.371e-06	2.505e-05	1.588e-08	4.751e-08
0.4	3.696e+06	9.525e-03	2.405e-02	1.856e-05	4.686e-05
0.5	1.320e+06	4.605e-03	1.035e-02	9.038e-06	2.031e-05
0.6	3.560e+11	1.588e+03	3.271e+03	3.100e+00	6.386e+00
0.8	2.148e+08	1.409e+00	2.560e+00	2.680e-03	4.869e-03
1.0	4.552e+09	4.016e+01	6.743e+01	7.402e-02	1.243e-01
1.5	4.594e+09	6.884e+01	1.020e+02	1.158e-01	1.715e-01
TOTALS:	3.945e+11	1.699e+03	3.446e+03	3.296e+00	6.699e+00

Results - Dose Point # 6 - (2021.86,302,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	2.544e-01	7.483e-01	2.521e-03	7.416e-03
0.04	5.603e+09	2.033e-01	9.647e-01	8.992e-04	4.267e-03
0.05	2.678e+07	2.047e-03	1.354e-02	5.452e-06	3.608e-05
0.1	2.096e+08	7.390e-02	5.111e-01	1.131e-04	7.819e-04

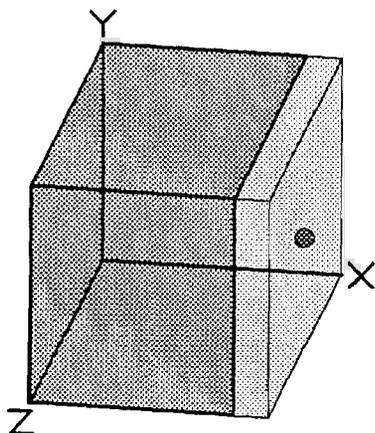
Page : 4
 DOS File: PM2A709.MS5
 Run Date: November 30, 2003
 Run Time: 9:56:41 PM
 Duration: 00:01:39

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.2	3.538e+07	3.452e-02	1.371e-01	6.093e-05	2.419e-04
0.3	4.807e+03	8.196e-06	2.463e-05	1.555e-08	4.672e-08
0.4	3.696e+06	9.330e-03	2.365e-02	1.818e-05	4.608e-05
0.5	1.320e+06	4.512e-03	1.018e-02	8.857e-06	1.997e-05
0.6	3.560e+11	1.557e+03	3.218e+03	3.039e+00	6.280e+00
0.8	2.148e+08	1.382e+00	2.518e+00	2.628e-03	4.789e-03
1.0	4.552e+09	3.939e+01	6.633e+01	7.262e-02	1.223e-01
1.5	4.594e+09	6.758e+01	1.003e+02	1.137e-01	1.688e-01
TOTALS:	3.945e+11	1.666e+03	3.389e+03	3.231e+00	6.589e+00

Page : 1
 DOS File: PM2AWB.MS5
 Run Date: June 12, 2003
 Run Time: 11:02:14 PM
 Duration: 00:00:15

File Ref: _____
 Date: _____
 By: _____
 Checked: _____

Case Title:
 Description: Rad Field due to waste bin with 40 % of Tank Sludge
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	182.9 cm	6 ft 0.0 in
Width	365.8 cm	12 ft 0.0 in
Height	200.0 cm	6 ft 6.7 in

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	214.015 cm	100 cm	182.9 cm
	7 ft 0.3 in	3 ft 3.4 in	6 ft 0.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.34e+07 cm ³	Concrete	0.605
Shield 1	.635 cm	Iron	7.86
Shield 2	30.48 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded
 Library : Grove

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	5.5300e+000	2.0461e+011	4.1327e-001	1.5291e+004
Co-60	1.1400e-001	4.2180e+009	8.5196e-003	3.1522e+002
Cs-134				
Cs-137	5.8460e+000	2.1630e+011	4.3689e-001	1.6165e+004
Eu-154	3.1400e-002	1.1618e+009	2.3466e-003	8.6825e+001
Sr-90	2.0740e+001	7.6738e+011	1.5500e+000	5.7349e+004
Y-90	2.0740e+001	7.6738e+011	1.5500e+000	5.7349e+004

Buildup
 The material reference is : Shield 2

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	1.205e+10	2.347e-18	7.441e-17	2.326e-20	7.375e-19
0.04	3.081e+09	1.957e-08	1.341e-06	8.654e-11	5.930e-09

Page : 2
 DOS File: PM2AWB.MS5
 Run Date: June 12, 2003
 Run Time: 11:02:14 PM
 Duration: 00:00:15

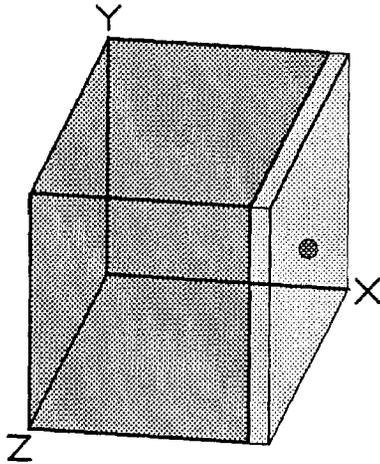
<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u> No Buildup	<u>MeV/cm²/sec</u> With Buildup	<u>mR/hr</u> No Buildup	<u>mR/hr</u> With Buildup
0.05	6.006e+07	4.358e-06	4.002e-04	1.161e-08	1.066e-06
0.1	4.701e+08	9.315e-01	2.815e+01	1.425e-03	4.306e-02
0.2	7.934e+07	1.821e+00	1.781e+01	3.214e-03	3.143e-02
0.4	8.289e+06	7.120e-01	3.634e+00	1.387e-03	7.081e-03
0.5	2.516e+06	3.183e-01	1.380e+00	6.248e-04	2.708e-03
0.6	1.842e+11	3.187e+04	1.220e+05	6.221e+01	2.382e+02
0.8	4.531e+08	1.282e+02	4.102e+02	2.438e-01	7.803e-01
1.0	4.575e+09	1.894e+03	5.365e+03	3.492e+00	9.890e+00
1.5	4.671e+09	3.839e+03	8.937e+03	6.458e+00	1.504e+01
TOTALS:	2.097e+11	3.774e+04	1.368e+05	7.241e+01	2.639e+02

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: PM2AWB.MS5
 Run Date: June 12, 2003
 Run Time: 11:21:04 PM
 Duration: 00:00:16

File Ref: _____
 Date: _____
 By: _____
 Checked: _____

Case Title:
 Description: Rad Field due to waste bin with 40 % of TS/DE-6" conc.
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	182.9 cm	6 ft 0.0 in
Width	365.8 cm	12 ft 0.0 in
Height	200.0 cm	6 ft 6.7 in

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	199.775 cm	100 cm	182.9 cm
	6 ft 6.7 in	3 ft 3.4 in	6 ft 0.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.34e+07 cm ³	Concrete	0.605
Shield 1	.635 cm	Iron	7.86
Shield 2	15.24 cm	Concrete	2.35
Shield 3	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Library : Grove				
<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	5.5300e+000	2.0461e+011	4.1327e-001	1.5291e+004
Co-60	1.1400e-001	4.2180e+009	8.5196e-003	3.1522e+002
Cs-134				
Cs-137	5.8460e+000	2.1630e+011	4.3689e-001	1.6165e+004
Eu-154	3.1400e-002	1.1618e+009	2.3466e-003	8.6825e+001
Sr-90	2.0740e+001	7.6738e+011	1.5500e+000	5.7349e+004
Y-90	2.0740e+001	7.6738e+011	1.5500e+000	5.7349e+004

Buildup
 The material reference is : Shield 2

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Results					
<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	1.205e+10	2.736e-36	2.884e-23	2.711e-38	2.858e-25

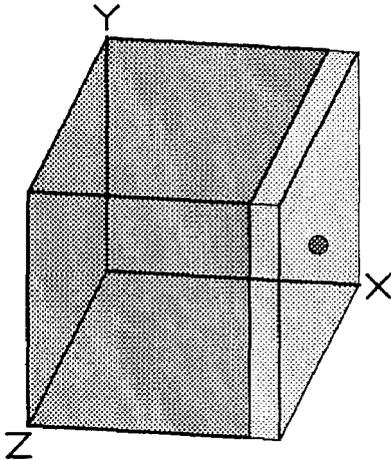
Page : 2
 DOS File: PM2AWB.MS5
 Run Date: June 12, 2003
 Run Time: 11:21:04 PM
 Duration: 00:00:16

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		No Buildup	With Buildup	No Buildup	With Buildup
0.04	3.081e+09	1.569e-17	6.303e-17	6.939e-20	2.787e-19
0.05	6.006e+07	4.334e-12	3.134e-11	1.155e-14	8.347e-14
0.1	4.701e+08	7.160e-04	1.761e-02	1.095e-06	2.694e-05
0.2	7.934e+07	6.463e-03	1.749e-01	1.141e-05	3.086e-04
0.4	8.289e+06	7.812e-03	1.295e-01	1.522e-05	2.524e-04
0.5	2.516e+06	4.923e-03	6.626e-02	9.663e-06	1.301e-04
0.6	1.842e+11	6.471e+02	7.301e+03	1.263e+00	1.425e+01
0.8	4.531e+08	3.944e+00	3.379e+01	7.503e-03	6.426e-02
1.0	4.575e+09	7.946e+01	5.524e+02	1.465e-01	1.018e+00
1.5	4.671e+09	2.730e+02	1.338e+03	4.592e-01	2.251e+00
TOTALS:	2.097e+11	1.004e+03	9.226e+03	1.876e+00	1.759e+01

Page : 1
 DOS File: PM2AWB.MS5
 Run Date: June 12, 2003
 Run Time: 11:28:58 PM
 Duration: 00:00:16

File Ref: _____
 Date: _____
 By: _____
 Checked: _____

Case Title:
 Description: Rad Field due to waste bin with 40 % of TS/DE-9" conc.
 Geometry: 13 - Rectangular Volume



Source Dimensions
 Length 182.9 cm 6 ft 0.0 in
 Width 365.8 cm 12 ft 0.0 in
 Height 200.0 cm 6 ft 6.7 in

Dose Points
 # 1 X Y Z
 207.396 cm 100 cm 182.9 cm
 6 ft 9.7 in 3 ft 3.4 in 6 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.34e+07 cm ³	Concrete	0.605
Shield 1	.635 cm	Iron	7.86
Shield 2	22.86 cm	Concrete	2.35
Shield 3	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Library : Grove

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	5.5300e+000	2.0461e+011	4.1327e-001	1.5291e+004
Co-60	1.1400e-001	4.2180e+009	8.5196e-003	3.1522e+002
Cs-134				
Cs-137	5.8460e+000	2.1630e+011	4.3689e-001	1.6165e+004
Eu-154	3.1400e-002	1.1618e+009	2.3466e-003	8.6825e+001
Sr-90	2.0740e+001	7.6738e+011	1.5500e+000	5.7349e+004
Y-90	2.0740e+001	7.6738e+011	1.5500e+000	5.7349e+004

Buildup
 The material reference is : Shield 2

Integration Parameters
 X Direction 10
 Y Direction 20
 Z Direction 20

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm ² /sec No Buildup	Results		Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
			Fluence Rate MeV/cm ² /sec With Buildup			
0.03	1.205e+10	2.694e-45	2.582e-23		2.669e-47	2.559e-25

Page : 2
 DOS File: PM2AWB.MS5
 Run Date: June 12, 2003
 Run Time: 11:28:58 PM
 Duration: 00:00:16

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		No Buildup	With Buildup	No Buildup	With Buildup
0.04	3.081e+09	4.414e-22	1.813e-21	1.952e-24	8.020e-24
0.05	6.006e+07	4.758e-15	3.943e-14	1.267e-17	1.050e-16
0.1	4.701e+08	2.590e-05	9.256e-04	3.963e-08	1.416e-06
0.2	7.934e+07	5.206e-04	2.273e-02	9.188e-07	4.011e-05
0.4	8.289e+06	1.071e-03	2.726e-02	2.086e-06	5.312e-05
0.5	2.516e+06	7.885e-04	1.579e-02	1.548e-06	3.099e-05
0.6	1.842e+11	1.171e+02	1.913e+03	2.286e-01	3.734e+00
0.8	4.531e+08	8.581e-01	1.019e+01	1.632e-03	1.938e-02
1.0	4.575e+09	1.978e+01	1.843e+02	3.647e-02	3.397e-01
1.5	4.671e+09	8.506e+01	5.284e+02	1.431e-01	8.891e-01
TOTALS:	2.097e+11	2.228e+02	2.636e+03	4.098e-01	4.982e+00

Page : 2
 DOS File: PM2AWBB.MS5
 Run Date: November 20, 2003
 Run Time: 8:55:28 AM
 Duration: 00:00:16

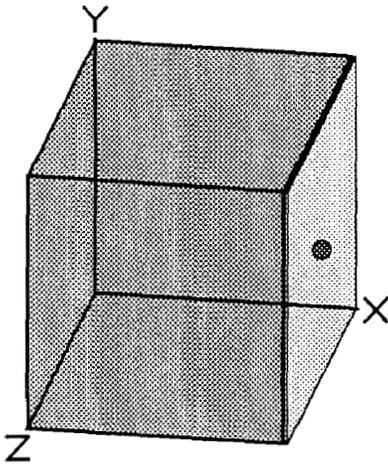
<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
		MeV/cm ² /sec <u>No Buildup</u>	MeV/cm ² /sec <u>With Buildup</u>	mR/hr <u>No Buildup</u>	mR/hr <u>With Buildup</u>
0.05	1.220e+07	5.379e-06	6.824e-06	1.433e-08	1.818e-08
0.1	9.548e+07	9.563e-01	1.729e+00	1.463e-03	2.645e-03
0.2	1.612e+07	1.876e+00	4.997e+00	3.311e-03	8.820e-03
0.4	1.684e+06	7.474e-01	2.204e+00	1.456e-03	4.294e-03
0.5	5.109e+05	3.362e-01	9.629e-01	6.600e-04	1.890e-03
0.6	3.741e+10	3.384e+04	9.317e+04	6.605e+01	1.819e+02
0.8	9.202e+07	1.372e+02	3.493e+02	2.610e-01	6.645e-01
1.0	9.293e+08	2.040e+03	4.845e+03	3.760e+00	8.932e+00
1.5	9.488e+08	4.171e+03	8.670e+03	7.018e+00	1.459e+01
TOTALS:	4.258e+10	4.019e+04	1.070e+05	7.709e+01	2.061e+02

(A) AREA TANKS — DEE AT FENCE

Page : 1
 DOS File: PM2AWBB.MS5
 Run Date: November 30, 2003
 Run Time: 9:34:56 PM
 Duration: 00:00:16

File Ref: _____
 Date: 01-Dec-03
 By: Alkhatir
 Checked: _____

Case Title:
 Description: Rad Field due to waste bin with 1/8" Pb for D. Kenoyer
 Geometry: 13 - Rectangular Volume



Source Dimensions

Length	121.9 cm	3 ft 12.0 in
Width	182.9 cm	6 ft 0.0 in
Height	121.9 cm	3 ft 12.0 in

Dose Points

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	123.86 cm	61 cm	91.4 cm
	4 ft 0.8 in	2 ft 0.0 in	2 ft 12.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.72e+06 cm ³	Concrete	0.605
Shield 1	.635 cm	Iron	7.86
Shield 2	.318 cm	Lead	11.34
Shield 3	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Library : Grove

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	1.1232e+000	4.1559e+010	4.1327e-001	1.5291e+004
Co-60	2.3155e-002	8.5672e+008	8.5196e-003	3.1522e+002
Cs-134				
Cs-137	1.1874e+000	4.3933e+010	4.3689e-001	1.6165e+004
Eu-154	6.3777e-003	2.3597e+008	2.3466e-003	8.6825e+001
Sr-90	4.2125e+000	1.5586e+011	1.5500e+000	5.7349e+004
Y-90	4.2125e+000	1.5586e+011	1.5500e+000	5.7349e+004

Buildup
 The material reference is : Shield 2

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.448e+09	8.958e-66	1.145e-23	8.878e-68	1.134e-25

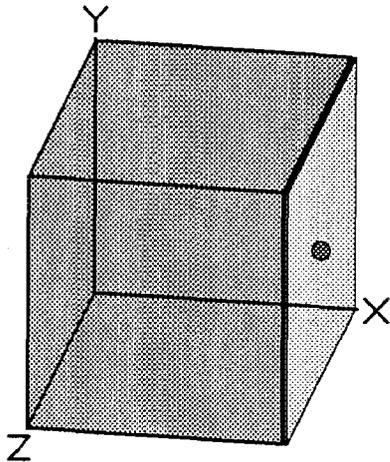
Page : 2
 DOS File: PM2AWBB.MS5
 Run Date: November 30, 2003
 Run Time: 9:34:56 PM
 Duration: 00:00:16

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.04	6.257e+08	1.384e-30	4.011e-24	6.120e-33	1.774e-26
0.05	1.220e+07	2.299e-18	2.477e-18	6.124e-21	6.598e-21
0.1	9.548e+07	5.778e-10	1.031e-03	8.839e-13	1.577e-06
0.2	1.612e+07	2.341e-02	3.038e-02	4.133e-05	5.361e-05
0.4	1.684e+06	2.236e-01	3.030e-01	4.357e-04	5.903e-04
0.5	5.109e+05	1.398e-01	2.001e-01	2.744e-04	3.929e-04
0.6	3.741e+10	1.674e+04	2.487e+04	3.268e+01	4.854e+01
0.8	9.202e+07	8.094e+01	1.274e+02	1.540e-01	2.423e-01
1.0	9.293e+08	1.315e+03	2.127e+03	2.424e+00	3.921e+00
1.5	9.488e+08	2.959e+03	4.717e+03	4.979e+00	7.936e+00
TOTALS:	4.258e+10	2.110e+04	3.184e+04	4.023e+01	6.065e+01

Page : 1
 DOS File: PM2AWBB.MS5
 Run Date: November 30, 2003
 Run Time: 9:39:22 PM
 Duration: 00:00:17

File Ref: _____
 Date: 11-30-03
 By: [Signature]
 Checked: _____

Case Title:
 Description: Rad Field due to waste bin with 1/4" Pb for D. Kenoyer
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	121.9 cm	3 ft 12.0 in
Width	182.9 cm	6 ft 0.0 in
Height	121.9 cm	3 ft 12.0 in

Dose Points			
#	<u>X</u>	<u>Y</u>	<u>Z</u>
1	124.28 cm	61 cm	91.4 cm
	4 ft 0.9 in	2 ft 0.0 in	2 ft 12.0 in

Shields			
Shield Name	Dimension	Material	Density
Source	2.72e+06 cm ³	Concrete	0.605
Shield 1	.635 cm	Iron	7.86
Shield 2	.635 cm	Lead	11.34
Shield 3	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	1.1232e+000	4.1559e+010	4.1327e-001	1.5291e+004
Co-60	2.3155e-002	8.5672e+008	8.5196e-003	3.1522e+002
Cs-134				
Cs-137	1.1874e+000	4.3933e+010	4.3689e-001	1.6165e+004
Eu-154	6.3777e-003	2.3597e+008	2.3466e-003	8.6825e+001
Sr-90	4.2125e+000	1.5586e+011	1.5500e+000	5.7349e+004
Y-90	4.2125e+000	1.5586e+011	1.5500e+000	5.7349e+004

Buildup
 The material reference is : Shield 2

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

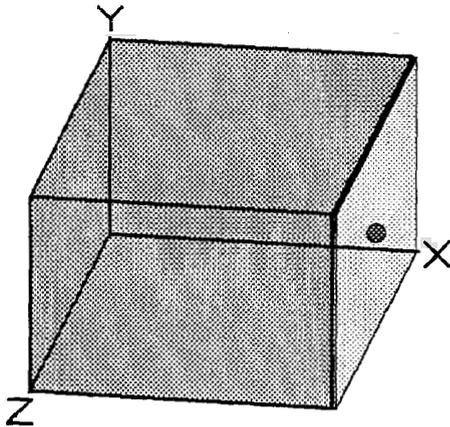
Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.448e+09	1.881e-111	1.127e-23	1.864e-113	1.117e-25

MicroShield v5.01 (5.01-00121)
 Lockheed Martin Idaho Technologies Company

Page : 1
 DOS File: PM2AWBB.MS5
 Run Date: December 1, 2003
 Run Time: 10:25:44 PM
 Duration: 00:00:17

File Ref:
 Date: 12/1/03
 By: [Signature]
 Checked:

Case Title:
 Description: Rad Field due to 2/3 full waste bin for D. Kenoyer
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	121.9 cm	3 ft 12.0 in
Width	182.9 cm	6 ft 0.0 in
Height	81.28 cm	2 ft 8.0 in

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	123.54 cm	40.64 cm	91.4 cm
	4 ft 0.6 in	1 ft 4.0 in	2 ft 12.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.81e+06 cm ³	Concrete	0.605
Shield 1	.635 cm	Iron	7.86
Shield 2	1.0 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Library : Grove				
<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	7.4893e-001	2.7710e+010	4.1327e-001	1.5291e+004
Co-60	1.5439e-002	5.7124e+008	8.5196e-003	3.1522e+002
Cs-134				
Cs-137	7.9172e-001	2.9294e+010	4.3689e-001	1.6165e+004
Eu-154	4.2525e-003	1.5734e+008	2.3466e-003	8.6825e+001
Sr-90	2.8088e+000	1.0393e+011	1.5500e+000	5.7349e+004
Y-90	2.8088e+000	1.0393e+011	1.5500e+000	5.7349e+004

Buildup
 The material reference is : Shield 1

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Results</u>			
		<u>Fluence Rate</u> MeV/cm ² /sec	<u>Fluence Rate</u> MeV/cm ² /sec	<u>Exposure Rate</u> mR/hr	<u>Exposure Rate</u> mR/hr
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	1.632e+09	1.116e-18	1.217e-18	1.106e-20	1.206e-20
0.04	4.172e+08	2.028e-08	2.371e-08	8.969e-11	1.049e-10

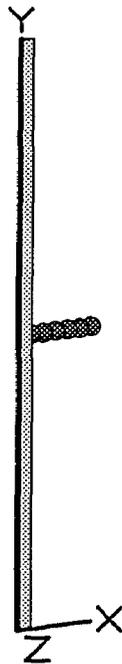
Page : 2
 DOS File: PM2AWBB.MS5
 Run Date: December 1, 2003
 Run Time: 10:25:44 PM
 Duration: 00:00:17

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u> No Buildup	<u>MeV/cm²/sec</u> With Buildup	<u>mR/hr</u> No Buildup	<u>mR/hr</u> With Buildup
0.05	8.134e+06	4.849e-06	6.156e-06	1.292e-08	1.640e-08
0.1	6.367e+07	9.558e-01	1.728e+00	1.462e-03	2.644e-03
0.2	1.075e+07	1.867e+00	4.937e+00	3.295e-03	8.714e-03
0.4	1.123e+06	7.362e-01	2.123e+00	1.435e-03	4.136e-03
0.5	3.407e+05	3.296e-01	9.184e-01	6.470e-04	1.803e-03
0.6	2.495e+10	3.302e+04	8.814e+04	6.445e+01	1.720e+02
0.8	6.136e+07	1.327e+02	3.262e+02	2.525e-01	6.205e-01
1.0	6.196e+08	1.958e+03	4.480e+03	3.609e+00	8.257e+00
1.5	6.326e+08	3.936e+03	7.870e+03	6.622e+00	1.324e+01
TOTALS:	2.839e+10	3.905e+04	1.008e+05	7.494e+01	1.942e+02

Page : 1
 DOS File: PM2ALINE.MS5
 Run Date: May 11, 2003
 Run Time: 12:55:25 PM
 Duration: 00:00:01

File Ref: _____
 Date: _____
 By: *[Signature]*
 Checked: 5/12/03

Case Title:
 Description: Radiation field due to vacuum line (5 gr/in)
 Geometry: 2 - Line



Source Dimensions
 Length 1.5e+3 cm 49 ft 2.6 in
 Angle 90.0°

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	30.5 cm	750 cm	0 cm
	1 ft 0.0 in	24 ft 7.3 in	0.0 in
# 2	61 cm	750 cm	0 cm
	2 ft 0.0 in	24 ft 7.3 in	0.0 in
# 3	91.5 cm	750 cm	0 cm
	3 ft 0.0 in	24 ft 7.3 in	0.0 in
# 4	122 cm	750 cm	0 cm
	4 ft 0.0 in	24 ft 7.3 in	0.0 in
# 5	152.5 cm	750 cm	0 cm
	5 ft 0.0 in	24 ft 7.3 in	0.0 in
# 6	183 cm	750 cm	0 cm
	6 ft 0.0 in	24 ft 7.3 in	0.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Shield 1	30.5 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm</u>	<u>Bq/cm</u>
Ba-137m	1.1700e-002	4.3290e+008	7.8000e+000	2.8860e+005
Co-60	1.3000e-004	4.8100e+006	8.6667e-002	3.2067e+003
Cs-134	4.0200e-007	1.4874e+004	2.6800e-004	9.9160e+000
Cs-137	1.2400e-002	4.5880e+008	8.2667e+000	3.0587e+005
Eu-154	1.5300e-005	5.6610e+005	1.0200e-002	3.7740e+002
Sr-90	1.2400e-002	4.5880e+008	8.2667e+000	3.0587e+005
Y-90	1.2400e-002	4.5880e+008	8.2667e+000	3.0587e+005

Buildup
 The material reference is : Shield 1

Integration Parameters
 Length Segments 30

Results - Dose Point # 1 - (30.5,750,0) cm

Page : 2
 DOS File: PM2ALINE.MS5
 Run Date: May 11, 2003
 Run Time: 12:55:25 PM
 Duration: 00:00:01

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.550e+07	3.961e+00	4.085e+00	3.926e-02	4.049e-02
0.04	6.133e+06	1.280e+00	1.320e+00	5.662e-03	5.840e-03
0.05	2.926e+04	7.658e-03	7.895e-03	2.040e-05	2.103e-05
0.1	2.291e+05	1.203e-01	1.230e-01	1.841e-04	1.882e-04
0.2	3.866e+04	4.072e-02	4.127e-02	7.187e-05	7.283e-05
0.3	5.265e+00	8.330e-06	8.415e-06	1.580e-08	1.596e-08
0.4	4.039e+03	8.527e-03	8.598e-03	1.662e-05	1.675e-05
0.5	1.443e+03	3.811e-03	3.837e-03	7.480e-06	7.532e-06
0.6	3.896e+08	1.235e+03	1.243e+03	2.411e+00	2.426e+00
0.8	2.348e+05	9.934e-01	9.982e-01	1.889e-03	1.899e-03
1.0	4.985e+06	2.638e+01	2.649e+01	4.863e-02	4.883e-02
1.5	5.031e+06	3.998e+01	4.011e+01	6.727e-02	6.748e-02
TOTALS:	4.318e+08	1.308e+03	1.316e+03	2.574e+00	2.591e+00

Results - Dose Point # 2 - (61,750,0) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.550e+07	1.888e+00	1.995e+00	1.871e-02	1.977e-02
0.04	6.133e+06	6.139e-01	6.487e-01	2.715e-03	2.869e-03
0.05	2.926e+04	3.681e-03	3.886e-03	9.806e-06	1.035e-05
0.1	2.291e+05	5.802e-02	6.033e-02	8.876e-05	9.230e-05
0.2	3.866e+04	1.967e-02	2.014e-02	3.471e-05	3.555e-05
0.3	5.265e+00	4.028e-06	4.101e-06	7.640e-09	7.779e-09
0.4	4.039e+03	4.126e-03	4.187e-03	8.039e-06	8.158e-06
0.5	1.443e+03	1.845e-03	1.868e-03	3.621e-06	3.666e-06
0.6	3.896e+08	5.983e+02	6.049e+02	1.168e+00	1.181e+00
0.8	2.348e+05	4.814e-01	4.856e-01	9.157e-04	9.237e-04
1.0	4.985e+06	1.279e+01	1.289e+01	2.358e-02	2.375e-02
1.5	5.031e+06	1.940e+01	1.951e+01	3.264e-02	3.282e-02
TOTALS:	4.318e+08	6.336e+02	6.405e+02	1.247e+00	1.261e+00

Results - Dose Point # 3 - (91.5,750,0) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.550e+07	1.203e+00	1.297e+00	1.192e-02	1.286e-02
0.04	6.133e+06	3.931e-01	4.240e-01	1.739e-03	1.875e-03
0.05	2.926e+04	2.361e-03	2.544e-03	6.291e-06	6.776e-06
0.1	2.291e+05	3.732e-02	3.937e-02	5.709e-05	6.024e-05
0.2	3.866e+04	1.267e-02	1.309e-02	2.236e-05	2.310e-05
0.3	5.265e+00	2.597e-06	2.662e-06	4.926e-09	5.049e-09
0.4	4.039e+03	2.662e-03	2.716e-03	5.187e-06	5.292e-06
0.5	1.443e+03	1.191e-03	1.211e-03	2.337e-06	2.377e-06
0.6	3.896e+08	3.864e+02	3.921e+02	7.541e-01	7.654e-01
0.8	2.348e+05	3.111e-01	3.148e-01	5.916e-04	5.987e-04
1.0	4.985e+06	8.268e+00	8.352e+00	1.524e-02	1.540e-02
1.5	5.031e+06	1.255e+01	1.264e+01	2.111e-02	2.127e-02

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
TOTALS:	4.318e+08	4.091e+02	4.152e+02	8.048e-01	8.175e-01

Results - Dose Point # 4 - (122,750,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.550e+07	8.631e-01	9.481e-01	8.554e-03	9.396e-03
0.04	6.133e+06	2.834e-01	3.113e-01	1.253e-03	1.377e-03
0.05	2.926e+04	1.706e-03	1.870e-03	4.543e-06	4.983e-06
0.1	2.291e+05	2.701e-02	2.887e-02	4.132e-05	4.417e-05
0.2	3.866e+04	9.184e-03	9.564e-03	1.621e-05	1.688e-05
0.3	5.265e+00	1.884e-06	1.943e-06	3.574e-09	3.685e-09
0.4	4.039e+03	1.932e-03	1.981e-03	3.765e-06	3.860e-06
0.5	1.443e+03	8.648e-04	8.832e-04	1.697e-06	1.734e-06
0.6	3.896e+08	2.807e+02	2.859e+02	5.478e-01	5.580e-01
0.8	2.348e+05	2.261e-01	2.294e-01	4.300e-04	4.364e-04
1.0	4.985e+06	6.011e+00	6.087e+00	1.108e-02	1.122e-02
1.5	5.031e+06	9.129e+00	9.215e+00	1.536e-02	1.550e-02
TOTALS:	4.318e+08	2.972e+02	3.027e+02	5.846e-01	5.960e-01

Results - Dose Point # 5 - (152.5,750,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.550e+07	6.612e-01	7.388e-01	6.553e-03	7.322e-03
0.04	6.133e+06	2.181e-01	2.436e-01	9.644e-04	1.078e-03
0.05	2.926e+04	1.314e-03	1.465e-03	3.501e-06	3.904e-06
0.1	2.291e+05	2.086e-02	2.257e-02	3.191e-05	3.452e-05
0.2	3.866e+04	7.102e-03	7.450e-03	1.253e-05	1.315e-05
0.3	5.265e+00	1.458e-06	1.512e-06	2.766e-09	2.868e-09
0.4	4.039e+03	1.496e-03	1.541e-03	2.915e-06	3.002e-06
0.5	1.443e+03	6.698e-04	6.867e-04	1.315e-06	1.348e-06
0.6	3.896e+08	2.175e+02	2.222e+02	4.244e-01	4.338e-01
0.8	2.348e+05	1.752e-01	1.783e-01	3.333e-04	3.392e-04
1.0	4.985e+06	4.661e+00	4.731e+00	8.591e-03	8.720e-03
1.5	5.031e+06	7.082e+00	7.161e+00	1.192e-02	1.205e-02
TOTALS:	4.318e+08	2.303e+02	2.353e+02	4.528e-01	4.633e-01

Results - Dose Point # 6 - (183,750,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.550e+07	5.279e-01	5.994e-01	5.232e-03	5.940e-03
0.04	6.133e+06	1.748e-01	1.984e-01	7.731e-04	8.777e-04
0.05	2.926e+04	1.055e-03	1.195e-03	2.811e-06	3.184e-06
0.1	2.291e+05	1.678e-02	1.836e-02	2.567e-05	2.809e-05
0.2	3.866e+04	5.720e-03	6.042e-03	1.010e-05	1.066e-05

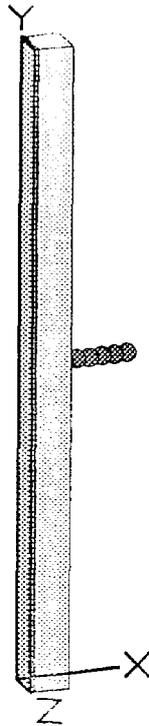
Page : 4
 DOS File: PM2ALINE.MS5
 Run Date: May 11, 2003
 Run Time: 12:55:25 PM
 Duration: 00:00:01

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.3	5.265e+00	1.175e-06	1.225e-06	2.229e-09	2.323e-09
0.4	4.039e+03	1.206e-03	1.248e-03	2.351e-06	2.431e-06
0.5	1.443e+03	5.403e-04	5.559e-04	1.061e-06	1.091e-06
0.6	3.896e+08	1.755e+02	1.799e+02	3.425e-01	3.511e-01
0.8	2.348e+05	1.415e-01	1.443e-01	2.691e-04	2.745e-04
1.0	4.985e+06	3.764e+00	3.828e+00	6.938e-03	7.057e-03
1.5	5.031e+06	5.722e+00	5.795e+00	9.627e-03	9.750e-03
TOTALS:	4.318e+08	1.858e+02	1.905e+02	3.654e-01	3.751e-01

Page : 1
 DOS File: PM2A709.M35
 Run Date: May 10, 2003
 Run Time: 7:50:21 PM
 Duration: 00:01:43

File Ref: _____
 Date: _____
 By:
 Checked: 5/12/03

Case Title: Tank 709
 Description: Rad field @ 3, 4, and 5 Ft. from sediment
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	9.86 cm	3.9 in
Width	91.44 cm	3 ft
Height	1.5e+3 cm	50 ft

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	91.44 cm 3 ft	762 cm 25 ft	45.72 cm 1 ft 6.0 in
# 2	121.92 cm 4 ft	762 cm 25 ft	45.72 cm 1 ft 6.0 in
# 3	152.4 cm 5 ft 0.0 in	762 cm 25 ft	45.72 cm 1 ft 6.0 in
# 4	182.88 cm 6 ft	762 cm 25 ft	45.72 cm 1 ft 6.0 in
# 5	213.36 cm 7 ft 0.0 in	762 cm 25 ft	45.72 cm 1 ft 6.0 in
# 6	243.84 cm 8 ft	762 cm 25 ft	45.72 cm 1 ft 6.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.37e+06 cm ³	Concrete 2	
Shield 1	81.58 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup
 The material reference is : Shield 1

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Page : 2
 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 7:50:21 PM
 Duration: 00:01:43

Results - Dose Point # 1 - (91.44,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	3.410e+01	7.627e+01	3.380e-01	7.559e-01
0.04	5.603e+09	2.232e+01	7.729e+01	9.871e-02	3.418e-01
0.05	2.678e+07	2.080e-01	1.004e+00	5.540e-04	2.675e-03
0.1	2.096e+08	6.844e+00	3.783e+01	1.047e-02	5.788e-02
0.2	3.538e+07	3.052e+00	1.071e+01	5.386e-03	1.889e-02
0.3	4.807e+03	7.072e-04	1.962e-03	1.342e-06	3.722e-06
0.4	3.696e+06	7.935e-01	1.905e+00	1.546e-03	3.712e-03
0.5	1.320e+06	3.801e-01	8.258e-01	7.460e-04	1.621e-03
0.6	3.560e+11	1.303e+05	2.626e+05	2.543e+02	5.126e+02
0.8	2.148e+08	1.147e+02	2.074e+02	2.183e-01	3.945e-01
1.0	4.552e+09	3.259e+03	5.492e+03	6.007e+00	1.012e+01
1.5	4.594e+09	5.578e+03	8.397e+03	9.385e+00	1.413e+01
TOTALS:	3.945e+11	1.393e+05	2.769e+05	2.704e+02	5.384e+02

Results - Dose Point # 2 - (121.92,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	2.540e+01	5.727e+01	2.517e-01	5.676e-01
0.04	5.603e+09	1.667e+01	5.820e+01	7.374e-02	2.574e-01
0.05	2.678e+07	1.557e-01	7.583e-01	4.147e-04	2.020e-03
0.1	2.096e+08	5.137e+00	2.850e+01	7.858e-03	4.360e-02
0.2	3.538e+07	2.292e+00	8.038e+00	4.046e-03	1.419e-02
0.3	4.807e+03	5.314e-04	1.472e-03	1.008e-06	2.793e-06
0.4	3.696e+06	5.963e-01	1.429e+00	1.162e-03	2.783e-03
0.5	1.320e+06	2.856e-01	6.190e-01	5.606e-04	1.215e-03
0.6	3.560e+11	9.789e+04	1.968e+05	1.911e+02	3.841e+02
0.8	2.148e+08	8.620e+01	1.553e+02	1.640e-01	2.954e-01
1.0	4.552e+09	2.448e+03	4.111e+03	4.512e+00	7.578e+00
1.5	4.594e+09	4.186e+03	6.280e+03	7.043e+00	1.057e+01
TOTALS:	3.945e+11	1.047e+05	2.075e+05	2.031e+02	4.035e+02

Results - Dose Point # 3 - (152.4,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	1.995e+01	4.522e+01	1.977e-01	4.482e-01
0.04	5.603e+09	1.314e+01	4.622e+01	5.811e-02	2.044e-01
0.05	2.678e+07	1.229e-01	6.037e-01	3.274e-04	1.608e-03
0.1	2.096e+08	4.067e+00	2.268e+01	6.222e-03	3.469e-02
0.2	3.538e+07	1.817e+00	6.382e+00	3.207e-03	1.126e-02
0.3	4.807e+03	4.214e-04	1.168e-03	7.993e-07	2.216e-06
0.4	3.696e+06	4.730e-01	1.133e+00	9.216e-04	2.207e-03
0.5	1.320e+06	2.266e-01	4.906e-01	4.447e-04	9.631e-04
0.6	3.560e+11	7.766e+04	1.559e+05	1.516e+02	3.044e+02
0.8	2.148e+08	6.839e+01	1.230e+02	1.301e-01	2.340e-01
1.0	4.552e+09	1.942e+03	3.254e+03	3.579e+00	5.999e+00

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u> No Buildup	<u>MeV/cm²/sec</u> With Buildup	<u>mR/hr</u> No Buildup	<u>mR/hr</u> With Buildup
1.5	4.594e+09	3.319e+03	4.966e+03	5.585e+00	8.355e+00
TOTALS:	3.945e+11	8.303e+04	1.644e+05	1.611e+02	3.197e+02

Results - Dose Point # 4 - (182.88,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u> No Buildup	<u>MeV/cm²/sec</u> With Buildup	<u>mR/hr</u> No Buildup	<u>mR/hr</u> With Buildup
0.03	2.330e+10	1.625e+01	3.708e+01	1.610e-01	3.674e-01
0.04	5.603e+09	1.074e+01	3.808e+01	4.751e-02	1.684e-01
0.05	2.678e+07	1.007e-01	4.983e-01	2.682e-04	1.327e-03
0.1	2.096e+08	3.339e+00	1.872e+01	5.109e-03	2.863e-02
0.2	3.538e+07	1.494e+00	5.257e+00	2.636e-03	9.278e-03
0.3	4.807e+03	3.466e-04	9.611e-04	6.574e-07	1.823e-06
0.4	3.696e+06	3.891e-01	9.316e-01	7.582e-04	1.815e-03
0.5	1.320e+06	1.864e-01	4.034e-01	3.659e-04	7.918e-04
0.6	3.560e+11	6.391e+04	1.282e+05	1.247e+02	2.502e+02
0.8	2.148e+08	5.627e+01	1.010e+02	1.070e-01	1.922e-01
1.0	4.552e+09	1.597e+03	2.672e+03	2.945e+00	4.925e+00
1.5	4.594e+09	2.730e+03	4.074e+03	4.593e+00	6.854e+00
TOTALS:	3.945e+11	6.832e+04	1.351e+05	1.326e+02	2.627e+02

Results - Dose Point # 5 - (213.36,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u> No Buildup	<u>MeV/cm²/sec</u> With Buildup	<u>mR/hr</u> No Buildup	<u>mR/hr</u> With Buildup
0.03	2.330e+10	1.358e+01	3.121e+01	1.346e-01	3.093e-01
0.04	5.603e+09	9.015e+00	3.220e+01	3.987e-02	1.424e-01
0.05	2.678e+07	8.463e-02	4.220e-01	2.255e-04	1.124e-03
0.1	2.096e+08	2.814e+00	1.585e+01	4.305e-03	2.425e-02
0.2	3.538e+07	1.260e+00	4.441e+00	2.224e-03	7.839e-03
0.3	4.807e+03	2.925e-04	8.114e-04	5.548e-07	1.539e-06
0.4	3.696e+06	3.285e-01	7.860e-01	6.400e-04	1.532e-03
0.5	1.320e+06	1.574e-01	3.402e-01	3.089e-04	6.678e-04
0.6	3.560e+11	5.395e+04	1.081e+05	1.053e+02	2.109e+02
0.8	2.148e+08	4.751e+01	8.513e+01	9.036e-02	1.619e-01
1.0	4.552e+09	1.348e+03	2.250e+03	2.486e+00	4.148e+00
1.5	4.594e+09	2.303e+03	3.428e+03	3.875e+00	5.767e+00
TOTALS:	3.945e+11	5.768e+04	1.139e+05	1.119e+02	2.215e+02

Results - Dose Point # 6 - (243.84,762,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		<u>MeV/cm²/sec</u> No Buildup	<u>MeV/cm²/sec</u> With Buildup	<u>mR/hr</u> No Buildup	<u>mR/hr</u> With Buildup
0.03	2.330e+10	1.158e+01	2.678e+01	1.147e-01	2.655e-01
0.04	5.603e+09	7.714e+00	2.775e+01	3.412e-02	1.227e-01
0.05	2.678e+07	7.254e-02	3.642e-01	1.932e-04	9.702e-04
0.1	2.096e+08	2.417e+00	1.367e+01	3.698e-03	2.092e-02

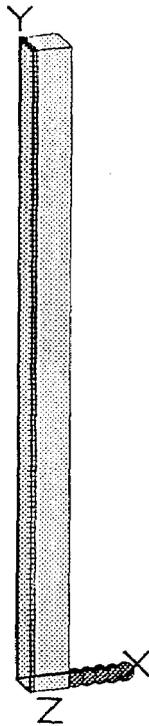
Page : 4
 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 7:50:21 PM
 Duration: 00:01:43

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.2	3.538e+07	1.083e+00	3.823e+00	1.912e-03	6.747e-03
0.3	4.807e+03	2.516e-04	6.978e-04	4.772e-07	1.324e-06
0.4	3.696e+06	2.826e-01	6.756e-01	5.506e-04	1.316e-03
0.5	1.320e+06	1.354e-01	2.923e-01	2.658e-04	5.737e-04
0.6	3.560e+11	4.642e+04	9.281e+04	9.061e+01	1.812e+02
0.8	2.148e+08	4.087e+01	7.308e+01	7.774e-02	1.390e-01
1.0	4.552e+09	1.160e+03	1.931e+03	2.138e+00	3.560e+00
1.5	4.594e+09	1.980e+03	2.939e+03	3.331e+00	4.945e+00
TOTALS:	3.945e+11	4.963e+04	9.782e+04	9.631e+01	1.902e+02

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 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 7:55:11 PM
 Duration: 00:02:20

File Ref: _____
 Date: _____
 By: *[Signature]*
 Checked: *5/12/03*

Case Title: Tank 709
 Description: Rad field @ 3, 4, and 5 Ft. from sediment
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	9.86 cm	3.9 in
Width	91.44 cm	3 ft
Height	1.5e+3 cm	50 ft

Dose Points			
	X	Y	Z
# 1	91.44 cm 3 ft	3 cm 1.2 in	45.72 cm 1 ft 6.0 in
# 2	121.92 cm 4 ft	3 cm 1.2 in	45.72 cm 1 ft 6.0 in
# 3	152.4 cm 5 ft 0.0 in	3 cm 1.2 in	45.72 cm 1 ft 6.0 in
# 4	182.88 cm 6 ft	3 cm 1.2 in	45.72 cm 1 ft 6.0 in
# 5	213.36 cm 7 ft 0.0 in	3 cm 1.2 in	45.72 cm 1 ft 6.0 in
# 6	243.84 cm 8 ft	3 cm 1.2 in	45.72 cm 1 ft 6.0 in

Shields			
Shield Name	Dimension	Material	Density
Source	1.37e+06 cm ³	Concrete	2
Shield 1	81.58 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup
 The material reference is : Shield 1

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

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 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 7:55:11 PM
 Duration: 00:02:20

Results - Dose Point # 1 - (91.44,3,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	1.768e+01	3.955e+01	1.752e-01	3.920e-01
0.04	5.603e+09	1.159e+01	4.017e+01	5.124e-02	1.777e-01
0.05	2.678e+07	1.080e-01	5.218e-01	2.877e-04	1.390e-03
0.1	2.096e+08	3.553e+00	1.959e+01	5.435e-03	2.996e-02
0.2	3.538e+07	1.583e+00	5.538e+00	2.794e-03	9.774e-03
0.3	4.807e+03	3.668e-04	1.015e-03	6.957e-07	1.926e-06
0.4	3.696e+06	4.114e-01	9.856e-01	8.016e-04	1.920e-03
0.5	1.320e+06	1.970e-01	4.273e-01	3.867e-04	8.387e-04
0.6	3.560e+11	6.752e+04	1.359e+05	1.318e+02	2.653e+02
0.8	2.148e+08	5.946e+01	1.073e+02	1.131e-01	2.042e-01
1.0	4.552e+09	1.688e+03	2.843e+03	3.112e+00	5.240e+00
1.5	4.594e+09	2.889e+03	4.348e+03	4.861e+00	7.315e+00
TOTALS:	3.945e+11	7.220e+04	1.433e+05	1.401e+02	2.786e+02

Results - Dose Point # 2 - (121.92,3,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	1.308e+01	2.952e+01	1.296e-01	2.926e-01
0.04	5.603e+09	8.608e+00	3.011e+01	3.807e-02	1.332e-01
0.05	2.678e+07	8.041e-02	3.921e-01	2.142e-04	1.044e-03
0.1	2.096e+08	2.653e+00	1.472e+01	4.059e-03	2.251e-02
0.2	3.538e+07	1.184e+00	4.153e+00	2.090e-03	7.329e-03
0.3	4.807e+03	2.745e-04	7.608e-04	5.206e-07	1.443e-06
0.4	3.696e+06	3.080e-01	7.384e-01	6.001e-04	1.439e-03
0.5	1.320e+06	1.475e-01	3.201e-01	2.896e-04	6.283e-04
0.6	3.560e+11	5.056e+04	1.018e+05	9.870e+01	1.987e+02
0.8	2.148e+08	4.453e+01	8.037e+01	8.470e-02	1.529e-01
1.0	4.552e+09	1.265e+03	2.128e+03	2.331e+00	3.923e+00
1.5	4.594e+09	2.164e+03	3.254e+03	3.641e+00	5.475e+00
TOTALS:	3.945e+11	5.406e+04	1.073e+05	1.049e+02	2.087e+02

Results - Dose Point # 3 - (152.4,3,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	2.330e+10	1.025e+01	2.331e+01	1.016e-01	2.311e-01
0.04	5.603e+09	6.777e+00	2.390e+01	2.997e-02	1.057e-01
0.05	2.678e+07	6.343e-02	3.120e-01	1.690e-04	8.312e-04
0.1	2.096e+08	2.100e+00	1.173e+01	3.212e-03	1.794e-02
0.2	3.538e+07	9.383e-01	3.306e+00	1.656e-03	5.835e-03
0.3	4.807e+03	2.177e-04	6.054e-04	4.129e-07	1.148e-06
0.4	3.696e+06	2.444e-01	5.875e-01	4.762e-04	1.145e-03
0.5	1.320e+06	1.171e-01	2.546e-01	2.299e-04	4.997e-04
0.6	3.560e+11	4.015e+04	8.095e+04	7.836e+01	1.580e+02
0.8	2.148e+08	3.537e+01	6.391e+01	6.728e-02	1.216e-01
1.0	4.552e+09	1.005e+03	1.692e+03	1.852e+00	3.119e+00

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 Duration: 00:02:20

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
1.5	4.594e+09	1.720e+03	2.587e+03	2.893e+00	4.352e+00
TOTALS:	3.945e+11	4.293e+04	8.536e+04	8.331e+01	1.660e+02

Results - Dose Point # 4 - (182.88,3,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	8.362e+00	1.916e+01	8.287e-02	1.899e-01
0.04	5.603e+09	5.549e+00	1.973e+01	2.454e-02	8.727e-02
0.05	2.678e+07	5.204e-02	2.582e-01	1.386e-04	6.877e-04
0.1	2.096e+08	1.728e+00	9.720e+00	2.643e-03	1.487e-02
0.2	3.538e+07	7.732e-01	2.738e+00	1.365e-03	4.832e-03
0.3	4.807e+03	1.795e-04	5.012e-04	3.406e-07	9.507e-07
0.4	3.696e+06	2.017e-01	4.862e-01	3.929e-04	9.474e-04
0.5	1.320e+06	9.666e-02	2.107e-01	1.897e-04	4.135e-04
0.6	3.560e+11	3.315e+04	6.698e+04	6.471e+01	1.307e+02
0.8	2.148e+08	2.922e+01	5.287e+01	5.557e-02	1.006e-01
1.0	4.552e+09	8.301e+02	1.400e+03	1.530e+00	2.580e+00
1.5	4.594e+09	1.421e+03	2.139e+03	2.391e+00	3.598e+00
TOTALS:	3.945e+11	3.545e+04	7.062e+04	6.880e+01	1.373e+02

Results - Dose Point # 5 - (213.36,3,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	7.013e+00	1.620e+01	6.950e-02	1.606e-01
0.04	5.603e+09	4.673e+00	1.675e+01	2.067e-02	7.408e-02
0.05	2.678e+07	4.390e-02	2.196e-01	1.170e-04	5.849e-04
0.1	2.096e+08	1.462e+00	8.281e+00	2.236e-03	1.267e-02
0.2	3.538e+07	6.551e-01	2.331e+00	1.156e-03	4.114e-03
0.3	4.807e+03	1.522e-04	4.266e-04	2.888e-07	8.092e-07
0.4	3.696e+06	1.711e-01	4.137e-01	3.333e-04	8.061e-04
0.5	1.320e+06	8.203e-02	1.792e-01	1.610e-04	3.518e-04
0.6	3.560e+11	2.814e+04	5.697e+04	5.493e+01	1.112e+02
0.8	2.148e+08	2.481e+01	4.496e+01	4.719e-02	8.552e-02
1.0	4.552e+09	7.051e+02	1.190e+03	1.300e+00	2.194e+00
1.5	4.594e+09	1.208e+03	1.818e+03	2.032e+00	3.059e+00
TOTALS:	3.945e+11	3.009e+04	6.007e+04	5.840e+01	1.168e+02

Results - Dose Point # 6 - (243.84,3,45.72) cm

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		MeV/cm ² /sec No Buildup	MeV/cm ² /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	2.330e+10	6.005e+00	1.398e+01	5.952e-02	1.386e-01
0.04	5.603e+09	4.018e+00	1.451e+01	1.777e-02	6.419e-02
0.05	2.678e+07	3.782e-02	1.906e-01	1.007e-04	5.077e-04
0.1	2.096e+08	1.262e+00	7.201e+00	1.931e-03	1.102e-02

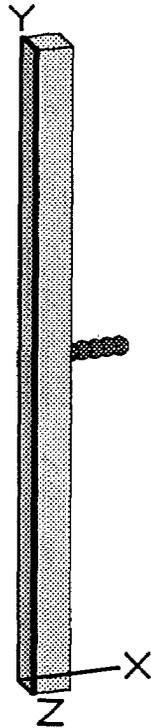
Page : 4
 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 7:55:11 PM
 Duration: 00:02:20

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.2	3.538e+07	5.666e-01	2.026e+00	9.999e-04	3.575e-03
0.3	4.807e+03	1.317e-04	3.705e-04	2.499e-07	7.028e-07
0.4	3.696e+06	1.481e-01	3.592e-01	2.886e-04	7.000e-04
0.5	1.320e+06	7.106e-02	1.556e-01	1.395e-04	3.054e-04
0.6	3.560e+11	2.438e+04	4.946e+04	4.759e+01	9.654e+01
0.8	2.148e+08	2.151e+01	3.902e+01	4.091e-02	7.422e-02
1.0	4.552e+09	6.113e+02	1.033e+03	1.127e+00	1.904e+00
1.5	4.594e+09	1.047e+03	1.577e+03	1.762e+00	2.654e+00
TOTALS:	3.945e+11	2.608e+04	5.214e+04	5.060e+01	1.014e+02

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 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 8:06:58 PM
 Duration: 00:01:32

File Ref: _____
 Date: _____
 By:
 Checked: 5/12/03

Case Title: Tank 709
 Description: Rad field @ 3, 4, and 5 Ft. from sediment
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	9.86 cm	3.9 in
Width	91.44 cm	3 ft
Height	1.5e+3 cm	50 ft

Dose Points			
	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	91.44 cm 3 ft	762 cm 25 ft	0 cm 0.0 in
# 2	121.92 cm 4 ft	762 cm 25 ft	0 cm 0.0 in
# 3	152.4 cm 5 ft 0.0 in	762 cm 25 ft	0 cm 0.0 in
# 4	182.88 cm 6 ft	762 cm 25 ft	0 cm 0.0 in
# 5	213.36 cm 7 ft 0.0 in	762 cm 25 ft	0 cm 0.0 in
# 6	243.84 cm 8 ft	762 cm 25 ft	0 cm 0.0 in

Shields			
<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	1.37e+06 cm ³	Concrete2	
Shield 1	81.58 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ba-137m	1.0690e+001	3.9553e+011	7.7800e+000	2.8786e+005
Co-60	1.1870e-001	4.3919e+009	8.6388e-002	3.1964e+003
Cs-134	3.6700e-004	1.3579e+007	2.6710e-004	9.8826e+000
Cs-137	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Eu-154	1.4000e-002	5.1800e+008	1.0189e-002	3.7699e+002
Sr-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005
Y-90	1.1300e+001	4.1810e+011	8.2239e+000	3.0429e+005

Buildup
 The material reference is : Shield 1

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Results - Dose Point # 1 - (91.44,762,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	2.798e+01	6.306e+01	2.773e-01	6.250e-01
0.04	5.603e+09	1.838e+01	6.394e+01	8.128e-02	2.828e-01
0.05	2.678e+07	1.716e-01	8.336e-01	4.571e-04	2.221e-03
0.1	2.096e+08	5.693e+00	3.252e+01	8.710e-03	4.975e-02
0.2	3.538e+07	2.556e+00	9.321e+00	4.511e-03	1.645e-02
0.3	4.807e+03	5.948e-04	1.712e-03	1.128e-06	3.247e-06
0.4	3.696e+06	6.696e-01	1.663e+00	1.305e-03	3.241e-03
0.5	1.320e+06	3.216e-01	7.216e-01	6.313e-04	1.416e-03
0.6	3.560e+11	1.105e+05	2.296e+05	2.157e+02	4.482e+02
0.8	2.148e+08	9.774e+01	1.816e+02	1.859e-01	3.453e-01
1.0	4.552e+09	2.785e+03	4.813e+03	5.134e+00	8.872e+00
1.5	4.594e+09	4.798e+03	7.376e+03	8.073e+00	1.241e+01
TOTALS:	3.945e+11	1.183e+05	2.422e+05	2.295e+02	4.708e+02

Results - Dose Point # 2 - (121.92,762,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	2.234e+01	5.059e+01	2.214e-01	5.013e-01
0.04	5.603e+09	1.470e+01	5.146e+01	6.500e-02	2.276e-01
0.05	2.678e+07	1.374e-01	6.721e-01	3.660e-04	1.791e-03
0.1	2.096e+08	4.560e+00	2.588e+01	6.976e-03	3.960e-02
0.2	3.538e+07	2.045e+00	7.364e+00	3.609e-03	1.300e-02
0.3	4.807e+03	4.754e-04	1.350e-03	9.017e-07	2.561e-06
0.4	3.696e+06	5.346e-01	1.311e+00	1.042e-03	2.554e-03
0.5	1.320e+06	2.566e-01	5.681e-01	5.036e-04	1.115e-03
0.6	3.560e+11	8.808e+04	1.807e+05	1.719e+02	3.527e+02
0.8	2.148e+08	7.778e+01	1.427e+02	1.479e-01	2.715e-01
1.0	4.552e+09	2.213e+03	3.780e+03	4.080e+00	6.968e+00
1.5	4.594e+09	3.802e+03	5.781e+03	6.396e+00	9.727e+00
TOTALS:	3.945e+11	9.422e+04	1.905e+05	1.829e+02	3.704e+02

Results - Dose Point # 3 - (152.4,762,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u>		<u>Exposure Rate</u>	
		<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	1.825e+01	4.153e+01	1.809e-01	4.116e-01
0.04	5.603e+09	1.204e+01	4.246e+01	5.326e-02	1.878e-01
0.05	2.678e+07	1.128e-01	5.555e-01	3.004e-04	1.480e-03
0.1	2.096e+08	3.746e+00	2.123e+01	5.731e-03	3.249e-02
0.2	3.538e+07	1.679e+00	6.011e+00	2.964e-03	1.061e-02
0.3	4.807e+03	3.903e-04	1.101e-03	7.403e-07	2.088e-06
0.4	3.696e+06	4.388e-01	1.068e+00	8.549e-04	2.081e-03
0.5	1.320e+06	2.105e-01	4.626e-01	4.131e-04	9.081e-04
0.6	3.560e+11	7.223e+04	1.471e+05	1.410e+02	2.871e+02
0.8	2.148e+08	6.372e+01	1.161e+02	1.212e-01	2.208e-01
1.0	4.552e+09	1.812e+03	3.072e+03	3.340e+00	5.663e+00

Page : 3
 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 8:06:58 PM
 Duration: 00:01:32

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
1.5	4.594e+09	3.107e+03	4.692e+03	5.227e+00	7.894e+00
TOTALS:	3.945e+11	7.725e+04	1.551e+05	1.499e+02	3.015e+02

Results - Dose Point # 4 - (182.88,762,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	1.523e+01	3.484e+01	1.510e-01	3.453e-01
0.04	5.603e+09	1.008e+01	3.580e+01	4.459e-02	1.583e-01
0.05	2.678e+07	9.454e-02	4.691e-01	2.519e-04	1.250e-03
0.1	2.096e+08	3.146e+00	1.785e+01	4.812e-03	2.730e-02
0.2	3.538e+07	1.410e+00	5.033e+00	2.489e-03	8.884e-03
0.3	4.807e+03	3.278e-04	9.207e-04	6.218e-07	1.747e-06
0.4	3.696e+06	3.685e-01	8.926e-01	7.179e-04	1.739e-03
0.5	1.320e+06	1.767e-01	3.865e-01	3.469e-04	7.587e-04
0.6	3.560e+11	6.063e+04	1.228e+05	1.183e+02	2.398e+02
0.8	2.148e+08	5.346e+01	9.687e+01	1.017e-01	1.842e-01
1.0	4.552e+09	1.519e+03	2.562e+03	2.801e+00	4.723e+00
1.5	4.594e+09	2.602e+03	3.909e+03	4.377e+00	6.576e+00
TOTALS:	3.945e+11	6.483e+04	1.295e+05	1.258e+02	2.518e+02

Results - Dose Point # 5 - (213.36,762,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	1.293e+01	2.977e+01	1.282e-01	2.950e-01
0.04	5.603e+09	8.591e+00	3.073e+01	3.800e-02	1.359e-01
0.05	2.678e+07	8.069e-02	4.031e-01	2.150e-04	1.074e-03
0.1	2.096e+08	2.689e+00	1.529e+01	4.114e-03	2.339e-02
0.2	3.538e+07	1.206e+00	4.298e+00	2.129e-03	7.585e-03
0.3	4.807e+03	2.804e-04	7.854e-04	5.319e-07	1.490e-06
0.4	3.696e+06	3.152e-01	7.609e-01	6.141e-04	1.483e-03
0.5	1.320e+06	1.511e-01	3.294e-01	2.966e-04	6.465e-04
0.6	3.560e+11	5.184e+04	1.046e+05	1.012e+02	2.042e+02
0.8	2.148e+08	4.570e+01	8.245e+01	8.692e-02	1.568e-01
1.0	4.552e+09	1.298e+03	2.180e+03	2.393e+00	4.018e+00
1.5	4.594e+09	2.221e+03	3.322e+03	3.736e+00	5.589e+00
TOTALS:	3.945e+11	5.543e+04	1.103e+05	1.076e+02	2.144e+02

Results - Dose Point # 6 - (243.84,762,0) cm

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.03	2.330e+10	1.114e+01	2.581e+01	1.104e-01	2.558e-01
0.04	5.603e+09	7.428e+00	2.675e+01	3.285e-02	1.183e-01
0.05	2.678e+07	6.988e-02	3.514e-01	1.861e-04	9.360e-04
0.1	2.096e+08	2.332e+00	1.329e+01	3.568e-03	2.033e-02

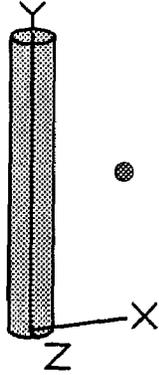
Page : 4
 DOS File: PM2A709.MS5
 Run Date: May 10, 2003
 Run Time: 8:06:58 PM
 Duration: 00:01:32

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.2	3.538e+07	1.047e+00	3.726e+00	1.848e-03	6.576e-03
0.3	4.807e+03	2.434e-04	6.802e-04	4.617e-07	1.290e-06
0.4	3.696e+06	2.736e-01	6.586e-01	5.330e-04	1.283e-03
0.5	1.320e+06	1.312e-01	2.850e-01	2.575e-04	5.593e-04
0.6	3.560e+11	4.499e+04	9.048e+04	8.781e+01	1.766e+02
0.8	2.148e+08	3.964e+01	7.126e+01	7.540e-02	1.355e-01
1.0	4.552e+09	1.126e+03	1.883e+03	2.075e+00	3.472e+00
1.5	4.594e+09	1.924e+03	2.867e+03	3.237e+00	4.824e+00
TOTALS:	3.945e+11	4.810e+04	9.538e+04	9.335e+01	1.854e+02

Page : 1
 DOS File: PM2AHEEL.MS5
 Run Date: June 13, 2003
 Run Time: 12:16:07 AM
 Duration: 00:00:06

File Ref: _____
 Date: _____
 By: _____
 Checked: _____

Case Title:
 Description: Rad field from 28320 cc heel of sludge
 Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions
 Height 121.92 cm 4 ft
 Radius 8.6 cm 3.4 in

Dose Points
 # 1 X 39.08 cm Y 61 cm Z 0 cm
 1 ft 3.4 in 2 ft 0.0 in 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.83e+04 cm ³	Concrete	1.35
Transition	30.48 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input

Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm ³
Ba-137m	4.2300e-002	1.5651e+009	1.4932e+000	5.5248e+004
Cs-137	4.4700e-002	1.6539e+009	1.5779e+000	5.8383e+004

Buildup

The material reference is : Transition

Integration Parameters

Radial 10
 Circumferential 10
 Y Direction (axial) 30

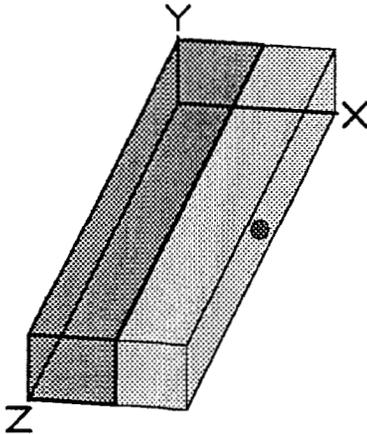
Results

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0318	3.240e+07	1.726e+00	4.085e+00	1.438e-02	3.403e-02
0.0322	5.978e+07	3.319e+00	7.992e+00	2.671e-02	6.432e-02
0.0364	2.175e+07	1.839e+00	5.329e+00	1.045e-02	3.028e-02
0.6616	1.408e+09	1.492e+04	2.643e+04	2.892e+01	5.125e+01
TOTALS:	1.522e+09	1.493e+04	2.645e+04	2.897e+01	5.137e+01

Page : 1
 DOS File: PM2AWB.MS5
 Run Date: May 11, 2003
 Run Time: 11:56:45 PM
 Duration: 00:00:24

File Ref: _____
 Date: _____
 By: *[Signature]*
 Checked: *5/12/03*

Case Title:
 Description: Rad Field due to waste bin with 25 % of Tank Sludge
 Geometry: 13 - Rectangular Volume



Source Dimensions		
Length	37.2 cm	1 ft 2.6 in
Width	363.2 cm	11 ft 11.0 in
Height	28.2 cm	11.1 in

Dose Points			
	X	Y	Z
# 1	68.315 cm	14.1 cm	181.6 cm
	2 ft 2.9 in	5.6 in	5 ft 11.5 in

Shields			
Shield Name	Dimension	Material	Density
Source	3.81e+05 cm ³	Concrete	1.3
Shield 1	.635 cm	Iron	7.86
Shield 2	30.48 cm	Air	0.0011
Air Gap		Air	0.00122

Source Input
 Grouping Method : Standard Indices
 Number of Groups : 25
 Lower Energy Cutoff : 0.015
 Photons < 0.015 : Excluded
 Library : Grove

Nuclide	curies	becquerels	μCi/cm ³	Bq/cm ³
Ba-137m	2.6700e+000	9.8790e+010	7.0077e+000	2.5928e+005
Co-60	2.9700e-002	1.0989e+009	7.7950e-002	2.8842e+003
Cs-134	9.1800e-005	3.3966e+006	2.4094e-004	8.9147e+000
Cs-137	2.8300e+000	1.0471e+011	7.4276e+000	2.7482e+005
Eu-154	3.5000e-003	1.2950e+008	9.1861e-003	3.3988e+002
Sr-90	2.8300e+000	1.0471e+011	7.4276e+000	2.7482e+005
Y-90	2.8300e+000	1.0471e+011	7.4276e+000	2.7482e+005

Buildup
 The material reference is : Shield 2

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm ² /sec	Results		Exposure Rate mR/hr	Exposure Rate mR/hr
			Fluence Rate MeV/cm ² /sec	Fluence Rate MeV/cm ² /sec		
0.03	5.819e+09	2.298e-17	No Buildup	With Buildup	2.277e-19	7.074e-18
0.04	1.400e+09	1.374e-07	No Buildup	With Buildup	6.076e-10	4.105e-08

Page : 2
 DOS File: PM2AWB.MS5
 Run Date: May 11, 2003
 Run Time: 11:56:45 PM
 Duration: 00:00:24

<u>Energy</u> MeV	<u>Activity</u> photons/sec	<u>Fluence Rate</u> MeV/cm ² /sec		<u>Exposure Rate</u> mR/hr	
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.05	6.694e+06	6.601e-06	5.827e-04	1.758e-08	1.552e-06
0.1	5.240e+07	8.620e-01	2.099e+01	1.319e-03	3.211e-02
0.2	8.844e+06	1.334e+00	1.043e+01	2.354e-03	1.841e-02
0.3	1.202e+03	3.824e-04	2.027e-03	7.253e-07	3.845e-06
0.4	9.239e+05	4.751e-01	2.014e+00	9.258e-04	3.925e-03
0.5	3.300e+05	2.440e-01	8.880e-01	4.789e-04	1.743e-03
0.6	8.891e+10	8.812e+04	2.858e+05	1.720e+02	5.578e+02
0.8	5.370e+07	8.431e+01	2.314e+02	1.604e-01	4.401e-01
1.0	1.139e+09	2.550e+03	6.255e+03	4.701e+00	1.153e+01
1.5	1.150e+09	4.867e+03	9.960e+03	8.189e+00	1.676e+01
TOTALS:	9.854e+10	9.563e+04	3.023e+05	1.851e+02	5.866e+02

EDF Title: PM-2A Half Tank Rigging

Project No.: 2000-096

Project Title: PM-2A Tanks and Burn Pits RD/RAWP

Problem Statement:

Design the rigging in compliance with DOE-ID Order 440C and DOE-STD-1090-2001 for lifting the upper half or lower half of a PM-2A tank and loading it on a low boy trailer.

Summary of Conclusions:

The rigging to lift a half of a 2 PM-2A tank shown on the Drawing PM-2A Half Tank Rigging meets the requirements of DOE-ID Order 440C and DOE-STD-1090-2001 and can be used to successfully lift and load a half tank on a low boy trailer. A detailed rigging plan will need to be developed by the subcontractor to provide clear instruction on how to use the developed equipment. The rigging plan should also include load testing the rigging to 125% of the weight of a half tank (1.25 X 33,425 = 41,782 lbs).

Review and Approval Signatures:

	R/A	Printed Name	Signature	Date
Prepared by:		Herbert L. Magleby	<i>Herbert L. Magleby</i>	12/03/03
Checked by:		<i>JKENDRER</i>	<i>Donald J. Kendrer</i>	03-DEC-03
Approval:		<i>GARY MERTON</i>	<i>Gary Merton</i>	12/3/03

Distribution:

Professional Engineer's Stamp (if required)



EDF Title: PM-2A Half Tank Rigging		EDF- 096 - 012	
Project No.: 2000-096		Rev No.: 2	
Project Title: PM-2A Tanks and Burn Pits RD/RAWP		Page 2 of 4	
Prepared by:	Date:	Checked by:	Date:

Problem Statement:

Rigging is to be designed in compliance with DOE-ID Order 440C and DOE-STD-1090-2001 to lift the upper or lower half of a PM-2A tank and load it on a low boy trailer.

Assumptions:

The half tanks each weigh 33,425 lbs. The half tanks are to be lifted with a mobile crane using a single hook. The tanks are to be rigged near the two end internal rib stiffeners of the tank each located about 11 feet from their respective end.

References:

DOE-ID Order 440C
DOE-STD-1090-2001
ASME B30.20a-2001
AISC Manual of Steel Construction
Machinery's Handbook
Consolidated Rigging and Marine Supply Internet Catalog (Attached)

Calculations / Analysis:

Acceptance Criteria

The rigging design is to meet the requirements of DOE-ID Order 440C. This Order invokes DOE-STD-1090-01 for rigging design. This Standard, Chapter 11 Wire Rope and Slings, specifies the allowable load for slings is to be the manufactures rated load based on a factor of safety of 5 with respect to the breaking strength. Tables of allowable loads for wire rope slings and synthetic-web slings are provided in the Standard. The rigging design of this EDF uses the manufacturer's rating as the allowable load and assures the loads are essentially within the limits of Tables in the Standard. Chapter 12 of the standard for Rigging Accessories does not specify a specific factor of safety for shackles but infers the allowable load is to be the manufactures rated load. The Chapter does not provide a table of allowable loads for shackles. The rigging design uses the manufactures rating as the allowable load. Chapter 14 of the standard invokes Section 20-1.2.2 of ASME B30.20 as the design criteria for Below-the-Hook Lifting Devices Structural and Mechanical Lifting Devices. Section 20-1.2.2 specifies a minimum design factor of three, based on yield strength of the material. Yield strength is not always the appropriate factor to limit, for example the buckling strength is the appropriate limit for the compressive stress in the spreader bar rather than the yield strength and .3 of the ultimate strength is the appropriate limit for shear stress for fillet welds. Also, the equations given in the AISC Manual of Steel Construction for the allowable bearing stress which were used to calculate the allowable loads for the lugs on the spreader bar are based on ultimate stress with a factor of safety of 2. The design of this EDF for the spreader bar uses the acceptance criteria of design factor of safety of three based on yield strength for tension stress and the acceptance criteria from the AISC Manual of Steel Construction with a factor of safety of 3 based on the limits from the Manual for bearing stress in the lug and shear stress in the welds. The allowable loads from the AISC Manual of Steel Construction include safety factors that provide for the uncertainties that are associated with typical simplifying assumptions and the use of nominal or average calculated stresses as the basis for manual methods of analysis. The safety factor of 3 used for the spreader bar design is in addition to the safety factors inherent in the AISC Manual of Steel Construction limits.

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Project No.: 2000-096		Rev No.: 2	
Project Title: PM-2A Tanks and Burn Pits RD/RAWP		Page 3 Of 4	
Prepared by:	Date:	Checked by:	Date:

Description of Rigging

Rigging has been designed in compliance with DOE-ID Order 440C and DOE-STD-1090-2001 to lift and load either the upper or lower half of the PM-2A tanks. The rigging is shown on the Drawing PM-2A Half Tank Rigging included in the design submittal. The results of the analyses that verify the adequacy of the design are shown in the attached table. The calculations are included as an attachment.

The rigging is designed to maintain a lifting angle of about 45° between the horizontal and the cables from the lifting beam to the crane hook and 60° between the horizontal and the straps. The lengths required to maintain the lifting angles result in an overall rigging length from the hook to the lower edge or bottom of the half tank of 34 ft. The overhead crane clearance was checked to see if there would be adequate clearance to accommodate the 34 ft rigging length. The attached sketch shows if the crane pivot center is located 110 ft from the center of the far half tank and the crane boom is extended to 121 ft, the lifting capacity of the crane is 36,000 lbs and there is 60 ft clear lift space which is more than the approximately 29 ft needed to clear the ground and load the half tank on a low boy trailer.

A sketch of the rigging is included as sheet 2 of the attached rigging design. The rigging uses a two leg sling with 1 1/4 inch diameter cables 24 feet long for each leg that attach to the upper flange of a spreader bar. Three inch wide nylon straps are wrapped around either the upper or lower half of the tank and connected to the lower flange of the spreader bar. Lugs fabricated from 3/4 inch steel plate are attached to the upper and lower flanges of the spreader bar with 9/16 inch fillet welds for the top lugs and 7/16 inch fillet welds for the bottom lugs. These lugs provide the attachment points for the legs of the sling and the ends of the straps. The tank is rigged near the two end internal stiffening ribs each located about 11 ft from their respective end. The spreader bar, a W 8X48 wide flange beam 33 ft 8 in long, is used to spread the cables when connected to the crane hook and provide vertical lifting force at the tank rigging points. Lifting lugs are welded to the top flange of the spreader bar so that the lifting cables with swaged open sockets can be connected to the spreader bar. The eyes on the end of the cables connected to the lifting ring at the crane hook are at right angles to the open sockets at the lifting beam end so that the connections can be made without a twist in the cable. An example of a two part sling with 1 inch cables rather than the 1 1/4 inch cables that are to be used for this design is attached. The vendor reported that they could supply the two part sling with the 1 1/4 inch cables. Lugs are welded to the lower flange at each end of the spreader beam to provide an attachment point for the straps. The lugs have two holes and each end of the straps is attached to the lugs with 1 inch shackles. The lugs on the bottom of the spreader beam are located directly under the lugs on the top so there is no bending force on the beam and the beam is loaded only in compression. Additional lifting lugs, top and bottom of the I beam, have been provided at the location of the two center internal stiffening ribs of the tank. These ribs are each located about 11 ft from their respective end stiffening rib or 22 ft. from the end of the tank. These additional lugs provide the ability to lift a shorter section of the half tank if it is cut into shorter sections. They also provide the ability to give more support to the half tanks if desired. If the additional center lifting lugs are used, the cables of the two leg sling must be moved to the center lugs mounted on the top flange of the spreader bar because the spreader bar is not designed to support the loads in bending. If the additional two internal lugs are used in conjunction with the outer lugs, a four leg sling would be used with the two internal cable lengths of 18 ft 3 inches. A detailed rigging plan is to be provided by the subcontractor describing the use of the rigging for lifting each half tank.

The analyses, that were performed to demonstrate the strength of the rigging is in compliance with DOE-STD-1090-2001, are included in the PM – 2A Half Tank Design Calculations which are attached. A summary of the results is shown in the attached Table. As shown in the attached table the acceptance criteria for all components of the rigging are met. The acceptance criteria for the two leg sling, the shackles and the synthetic web straps is the rated load; therefore, a safety factor of 1 based on the rated load meets the acceptance criteria. The safety factors for the design of the spreader bar for all components except the kl/r of the beam are greater than 3; therefore, the acceptance criteria for these components are met. The kl/r value of the spreader bar is only slightly less than the maximum of 200 recommended by the AISC Manual of steel construction for members loaded in compression. The kl/r is a go/no-go check to determine

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Prepared by:	Date:	Checked by:	Date:

the rules for determining the allowable compressive stress in the spreader bar apply and, therefore, a safety factor is not appropriate. A value of 1.00 or greater verifies the rules apply and is acceptable. The analysis using the rules show a factor of safety of 3.70 for the compressive stress in the spreader bar and the W8X48 beam is of adequate size for the spreader bar.

Attachments

Table: Summary of Results PM-2A Half Tank Rigging
 PM-2A Half Tank Rigging Design Calculations
 Reference Pages

**SUMMARY OF RESULTS
RIGGING ANALYSIS
PM-2A HALF TANK RIGGING**

EQUIPMENT DESCRIPTION	SPECIFICATION DOCUMENT	SPECIFIED CRITERIA	BASIS FOR SAFETY FACTOR	APPLIED LOAD OR STRESS	SAFETY FACTOR
1 1/4" Diam. Two leg sling	DOE-STD-1090 Sec. 11.3.1.2	Rated load	Manufacturer rating 36,000 lbs DOE-STD-1090 26,000 LBS	33,425 lbs	1.08 Based on rated load
Spreader bar	AISC Manual of Steel Construction B7	kl/r = 200 max recommended	200	190	1.05 go/no-go check. A value of 1.0 is acceptable
	* AISC Manual of Steel Construction B7	$F_a = \frac{12I^2E}{23(Kl/r)^2}$	4.14 ksi	1.12 ksi	3.70
Top lifting lugs Tension stress	DOE-STD-1090 14.2.1 invokes ASME B30.20-1.2.2	Safety Factor of 3 based on yield strength	$F_y = 36$ ksi	6.64 ksi	5.42
Bearing stress	*AISC Manual of Steel Construction J3.7	$F_p = \frac{L_c F_u}{2d}$	45.1 ksi	13.65 ksi	3.30
7/16" Fillet weld	*AISC Manual of Steel Construction J2.2	$0.3F_u$	21.0 ksi	6.48 ksi	3.24
Base metal at fillet weld	*AISC Manual of Steel Construction J2.2	$0.4F_y$	14.4 ksi	3.73 ksi	3.86
Lower lifting lugs Tension stress	DOE-STD-1090 14.2.1 invokes ASME B30.20-1.2.2	Safety Factor of 3 based on yield strength	$F_y = 36$ ksi	3.04 ksi	11.84
Bearing stress	* AISC Manual of Steel Construction J3.7	$F_p = \frac{L_c F_u}{2d}$	51.6 ksi	12.3 ksi	4.20
7/16" Fillet weld	*AISC Manual of Steel Construction J2.2	$0.3F_u$	21.0 ksi	2.68 ksi	7.84
Base metal at fillet weld	*AISC Manual of Steel Construction J2.2	$0.4F_y$	14.4 ksi	2.38 ksi	6.05
1" Chain link shackles for nylon straps	DOE-STD-1090 Sec. 12.3	Rated load	Manufacturer rating 17,000 lbs	10,200 lbs	1.67 Based on rated load
3" wide three ply nylon straps	DOE-STD-1090 Sec. 11.3.1.2	Rated load	Manufacturer rating 12,500 lbs	10,200 lbs	1.22 Based on rated load

* DOE-STD-1090 Section 14.2.1 invokes ASME B30.20-1.2.2 which specifies a safety factor of 3 based on yield stress. The allowable values for the stresses for the items marked with an asterisks are not usually based on the yield stress; therefore, the allowable values for these stresses from the AISC Manual of Steel Construction were used but the requirement used in the design was that the safety factor based on these stress must be greater than 3.

PM -2A HALF TANK
RIGGING DESIGN CALCULATIONS



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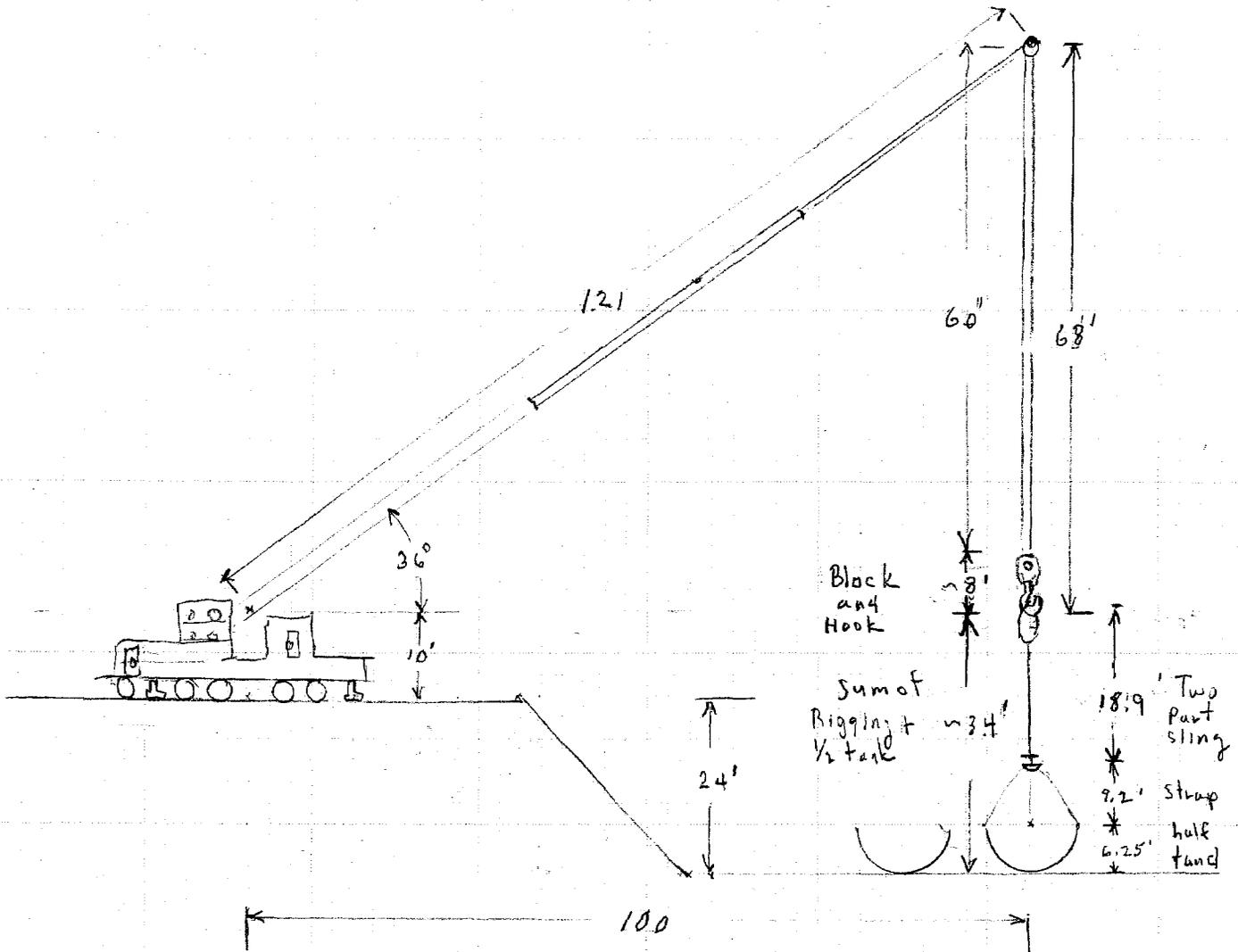
DATE 10/15/03

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Boom Angle and Lift Clearance



60' Clear Lift Space > 24' to clear ground + ~5' to load on low bay trailer = 29'

More than adequate clearance for lift with
 34.3 boom angle and 121' extension x Lift capacity
 36,000 > 33,425 weight of half tank



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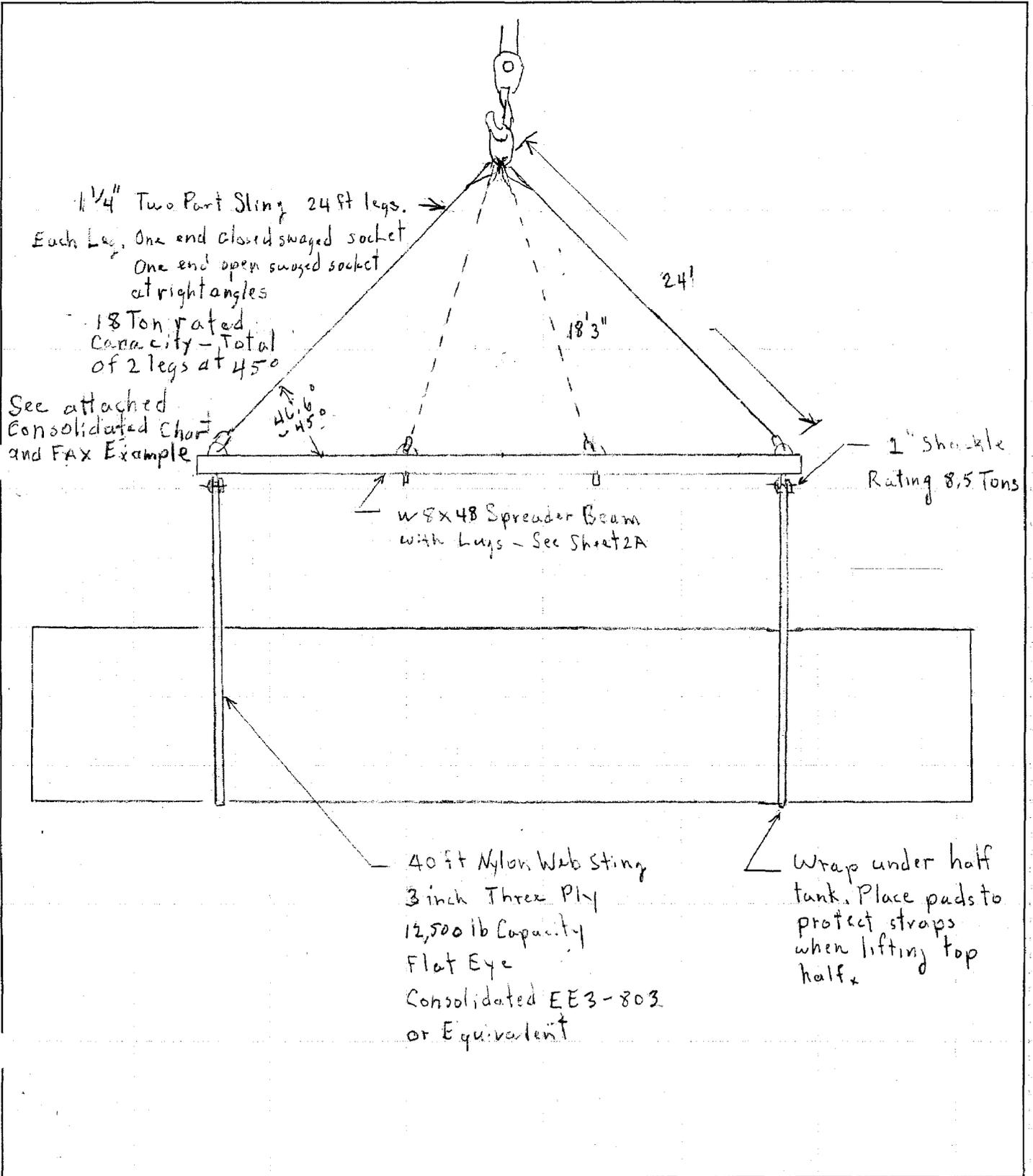
JOB PM 2A Half Tank Rigging - Rigging Design

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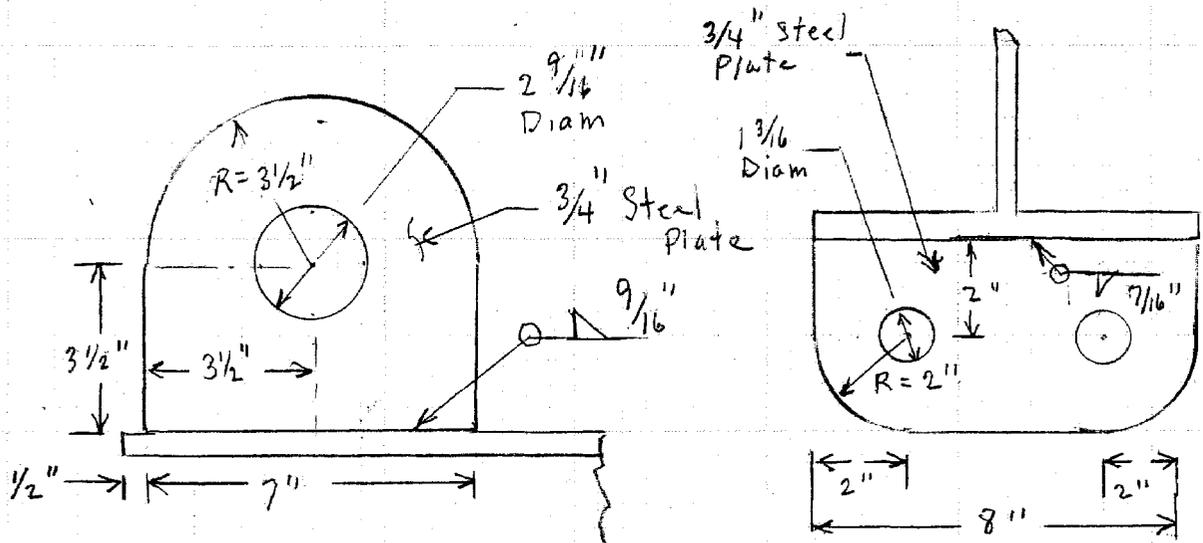
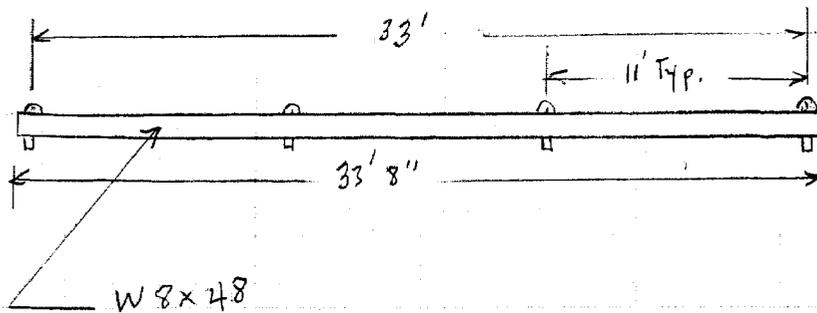




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JOB PM-2A Half Tank Riggings
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Spreader Beam



Top Lug

4 places

Bottom Lug

4 places



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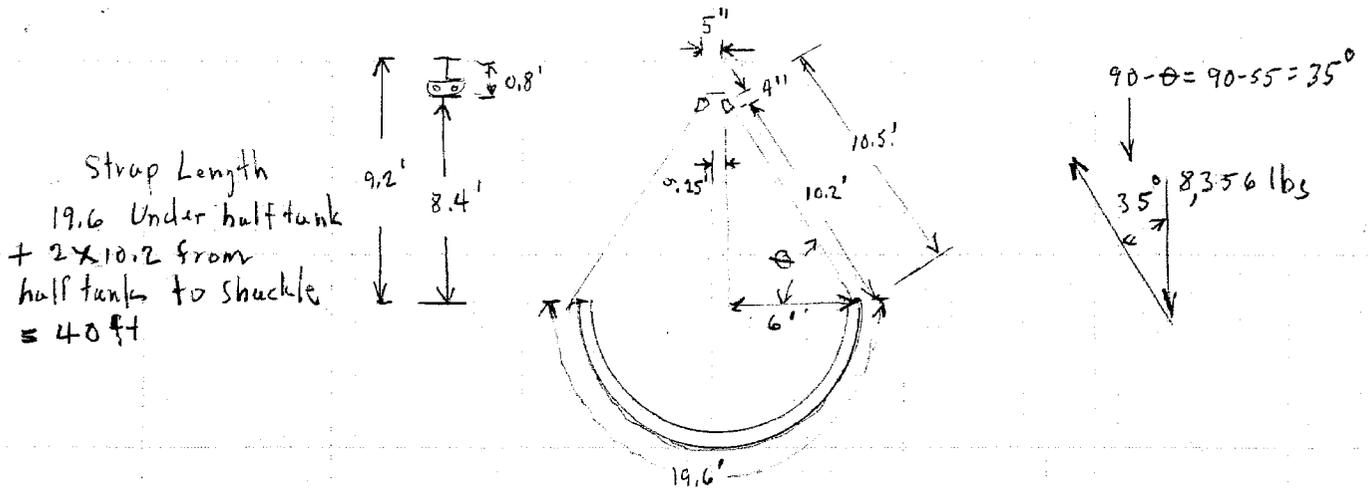
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Sling Length and Tension

Each leg of strap carries 1/2 of the load at the lug = $\frac{13,126}{2} = 6563 \text{ lbs}$



Strap Length
 19.6 Under half tank
 + 2 x 10.2 from
 half tanks to shackle
 = 40 ft

$$\theta = \cos^{-1} \frac{6.0}{10.5} = 55^\circ$$

6 Foot radius used because shackle attaches to lug about 0.25' from ϵ

Half Tank weight 16,712 lbs

Straps at two locations (11' from each end)

Load at each location 16,712 lbs

Supported by two legs or 8,358 lbs weight per each strap

Tension in strap $T_{\text{strap}} = \frac{8,356}{\cos 35^\circ} = 10,201 \text{ lbs}$

$T_{\text{strap}} = 5 \text{ Tons}$

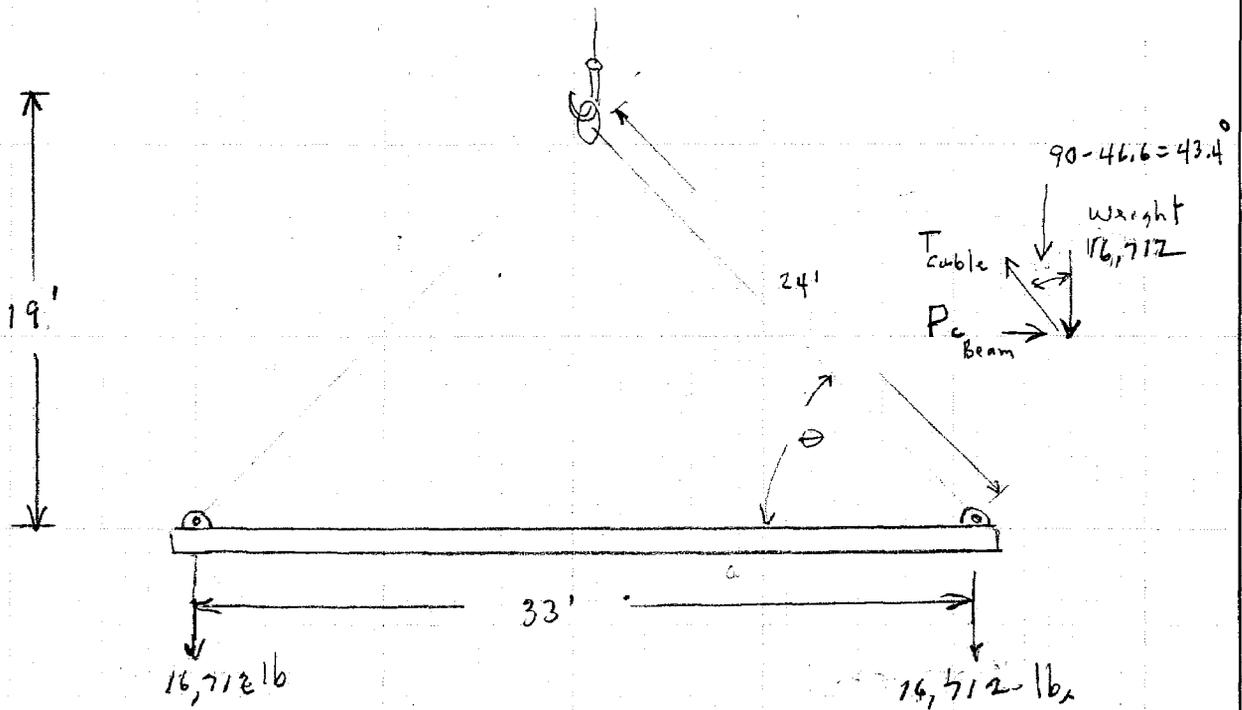
Consolidated Strap Three Ply EE3-803 Rating of 12,500 lbs
 (See attached Catalog Page) is adequate.



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Spreader Bar Compression and two part
 sling tension. Each leg of the sling carries
 $\frac{1}{2}$ of the full tank weight = $\frac{1}{2} = 16,712$ lbs.



$$\theta = \cos^{-1} \left(\frac{33/2}{24} \right) = 46.6^\circ \text{ Approximately } 45^\circ$$

$$\text{Height } 24 \sin 46.6 = 17.4' \text{ Add } 18'' \text{ For Ring.}$$

$$\text{Height} = 18.9'$$

$$\text{Tension in cable } T_{\text{cable}} = \frac{16,712}{\cos 43.4} = 23,039 \text{ lbs}$$

$$\text{Compression in beam } P_{c \text{ Beam}} = 23,039 \cos 46.6 = 15,830 \text{ lbs}$$



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Design Spreader Beam.

Beam Compression Load From Sheet 4 = 15,830 Kips.

Compression beams are usually limited to $\frac{kl}{r} = 200$
See AISC Manual Steel Construction Specification Section B7

Beam length $l = 33'$ or $396''$ Beam ends are free to

rotate. AISC Manual Steel Construction Table C.8.1

Both ends pinned $k = 1.0$

$$\frac{kl}{r} = 200 \quad r = \frac{kl}{200} = \frac{(1.0)(396)}{200} = 1.98$$

A W shape beam with $r > 1.98$

W8x48 $r = 2.08$ in

$A = 14.10$ in²

$$\frac{kl}{r} = \frac{(1.0)(396)}{2.08} = 190 \text{ Use weak axis Y-Y because beam can bend either way.}$$

Section E2 of the Specification Section AISC Manual of Steel

Construction

$$C_2 = \sqrt{\frac{2\pi^2 E}{F_y}} = \sqrt{\frac{2\pi^2 (29 \times 10^3)}{36}} = 126.1$$

$\frac{kl}{r} = 195 > 126.1$ Therefore equation E2-2 applies

$$F_a = \frac{12\pi^2 E}{23 (kl/r)^2} = \frac{(12)(\pi^2)(29 \times 10^3)}{(23)(190)^2} = 4.14 \text{ ksi.}$$

$$f_a = P_c/A = 15,830/14.1 = 1.12 \text{ ksi}$$

$f_a = 1.12 \text{ ksi} < 3.93 \text{ ksi}$ and W8x35 is adequate

$$S.F. = 4.14/1.12 = 3.70$$



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JOB PM-2 A Half Tank Rigging

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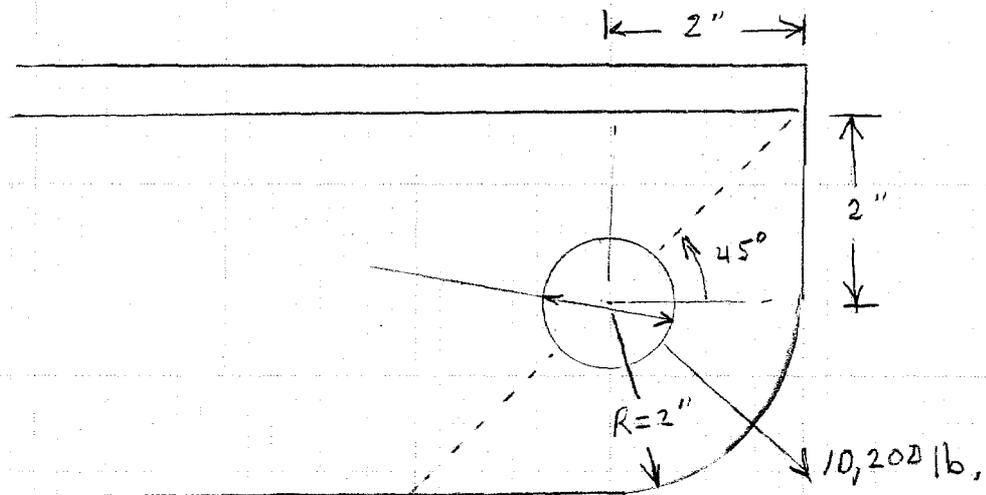
Tension Loads on Lugs Where Straps are Attached

Lugs will be fabricated from $\frac{3}{4}$ " steel plate

Material A36 $F_y = 36 \text{ ksi}$

1 inch shackle has a shackle bolt diameter of $1\frac{1}{8}$ "

The shackle bolt hole in the lug is $\frac{1}{16}$ " larger = $1\frac{3}{16}$ " diam



Minimum Tension area, which is at 45° , was used even though the actual load is at 55° . The use of min area and full load gives conservative result.

$$\begin{aligned} \text{Tension Area} &= (\text{plate thickness})(\text{net tension length}) \\ &= \frac{3}{4} (2 \times 2 / \cos 45^\circ - 1\frac{3}{16}) = 3.35 \text{ in}^2 \end{aligned}$$

$$f_a = P/A = 10,200 / 3.352 = 3,043 \text{ psi or } 3.04 \text{ ksi}$$

Factor of safety based on yield strength

$$S.F. = 36 / 3.04 = 11.84$$



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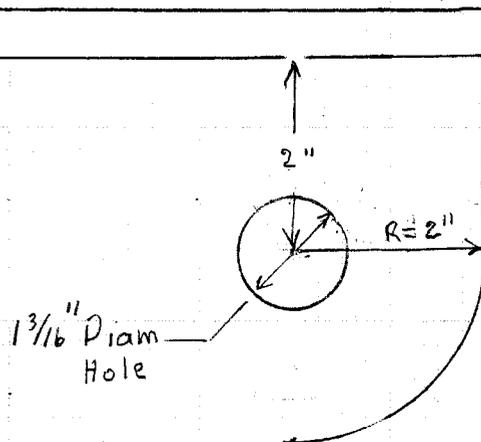
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SCALE _____

Bearing Loads on Lugs Where Straps are Attached.

Lug will be fabricated from $\frac{3}{4}$ " steel plate
Material A36 $F_y = 36$ ksi $F_u = 58$ ksi (minimum
for A36) 1 inch shackle, Shackle Bolt $1\frac{1}{8}$ " Hole $1\frac{1}{8} + \frac{1}{16} = 1\frac{3}{16}$ "



AISC Manual of Steel Construction Table I-E Page 4-6 Ninth Edition
Minimum edge distance - Center of hole to edge greater than $1.5d$

Minimum edge distance = $1.5(1.125) = 1.69$ inches (See Notes of Table I-E)

Edge distance $2" > 1.69$ inches required, and is adequate

For $F_u = 58$ ksi (Lowest value for all materials) and lug

thickness of $\frac{3}{4}$ " and a shackle pin diameter of 1" allowable load is 52.2 kips
(Table does not give values for $1\frac{1}{8}$ " pin but use of value for 1" pin is conservative)
Strap Load 10.2 < 52.2 allowable load and lug is adequate



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SHEET NO. 7

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Section J3.9 of the Specification in the Manual of Steel Construction also requires Minimum Edge Distance be greater than value from Table J3.5

For nominal bolt diameter of $1\frac{1}{8}$ " inch the minimum edge distance from center of hole to edge is $1\frac{1}{2}$ inches

$2 > 1\frac{1}{2}$ inches edge distance adequate

Also edge distance shall not be less than

$$L_e \geq 2P/F_{ut} = (2)(10.2)/(58)(0.75) = 0.469$$

$2 > 0.469$ edge distance is adequate,

Also Section J3.7 requires for single bolt in line of force

$$f_{\text{bearing}} < F_p$$

$$f_{\text{bearing}} = P/dt = 10.4/(1.125)(0.75) = 12.326 \text{ ksi.}$$

$$F_p = L_e F_u / 2d = (2)(58)/(2)(1.125) = 51.6 \text{ but not to exceed}$$

where L_e = distance from free edge to center of hole)

$$1.2F_u = (1.2)(58) = 69.6 \text{ Use lower of 51.6 and 69.6}$$

Pin Bearing Stress $12.3 < 51.6$ ksi allowable stress
Factor of Safety $51.6/12.3 = 4.20$

Bearing of $1\frac{1}{8}$ " diam bolt of inch shackle well below allowable.

Lug with $\frac{3}{4}$ " plate $1\frac{3}{16}$ " hole and 2" radius to edge of plate is adequate with large margin.



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JOB PM-2A Half Tank Rigging

SHEET NO. 7A

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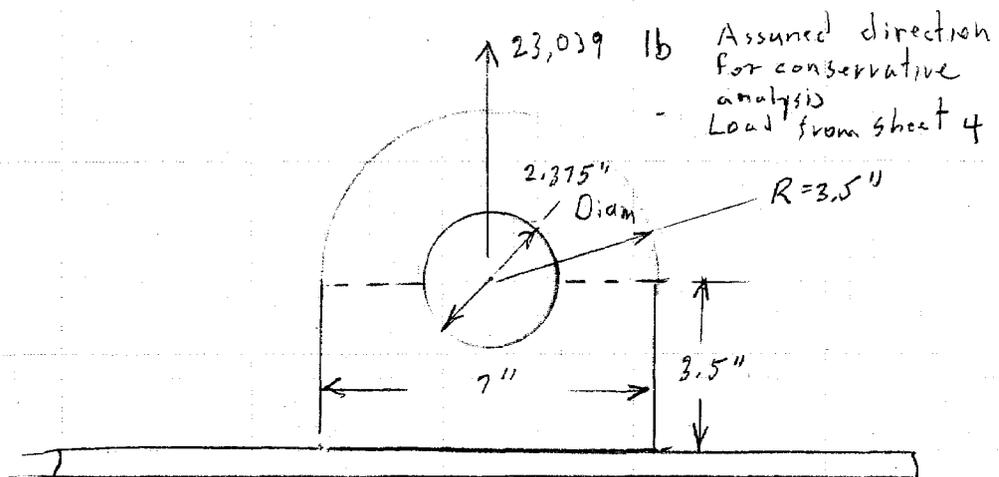
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Tension Loads on lugs where cables of two part sling are attached.

Lugs will be fabricated from $3/4$ " plate. Material A36 $F_y = 36$ ksi. The open swaged socket pin on the two part sling will be $2 1/4$ diameter. The hole will be $2 3/8" = 2.375"$ diameter.



Minimum tension area was used even though the actual load is at 45° . The use of the minimum area and full load gives conservative results.

$$\text{Tension area} = 3/4(7 - 2.375) = 3.47 \text{ in}^2$$

$$f_u = \frac{P}{A} = 23,039 / 3.47 = 6,639 \text{ psi or } 6.64 \text{ ksi}$$

Factor of Safety based on yield strength

$$S.F. = 36 / 6.64 = 5.42$$



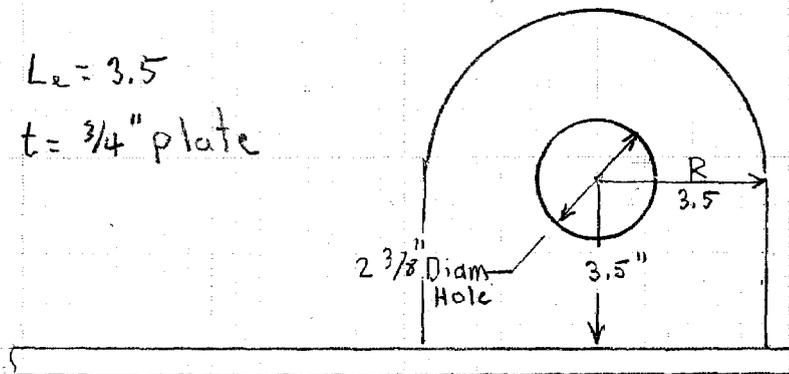
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JOB PM-2A Rigging
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CALCULATED BY Lowell DATE 10/16/03
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Bearing Loads on Lugs where cables of two part sling are attached.

Two part sling has $1\frac{1}{8}$ inch cables. Open swaged socket has $2\frac{1}{4}$ diameter pin. Diameter of hole will be $2\frac{3}{8} = 2.375$ "

$L_e = 3.5$
 $t = \frac{3}{4}$ " plate



Section J3.7 of Specification in Manual of Steel Construction

Allowable bearing stress for single bolt in the line of force

$$F_p = L_e F_u / 2d \leq 1.2 F_u = (3.5)(58) / (2)(2.25) = 45.1 \text{ ksi}$$

$$F_p = 45.1 \text{ ksi} < (1.2)(58) = 69.6 \text{ ksi}$$

Use lower value 45.1 ksi as allowable



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Bearing stress in lug from load.

Tension in cable from sheet 4. $P = T_2 = 23.04$ kips

$$f_{\text{Bearing}} = P/A = P/dt = (23.04)/(2.25)(0.75)$$

$$f_{\text{Bearing}} = 13.65 \text{ ksi}$$

Pin Bearing Stress = 13.65 < 45.1 ksi Allowable
Factor of Safety $45.1/13.65 = 3.30$

Section J3.9 of Specification in Manual of

Steel Construction Minimum edge distance to
be greater than value per Table J3.5. From
Table for pin diameter over 1 1/4 inch

$$\begin{aligned} \text{Minimum edge distance} &= 1.25 \text{ Dia} = (1.25)(2.25) \\ &= 2.81 \text{ inches} \end{aligned}$$

Edge Distance of Lug = 3.5 > 2.81 inches required.

Section J3.9 also required the minimum edge
distance

$$L_e \geq 2P/F_{ut} = (2)(23.04)/(58)(0.75)$$

$$L_e \geq 1.059 \text{ inches}$$

Edge distance of lug = 3.5 > 1.059 inches required

Lug bearing stress is acceptable and edge distance
is adequate.



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SHEET NO. 10

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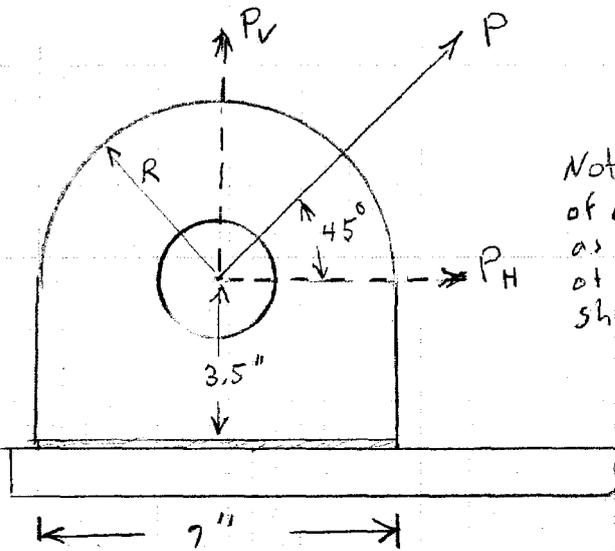
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Design fillet weld of lifting lug on top of beam for connection to the two part sling,



Note The angle of 45° was used as an approximation of the 46.6° from sheet 4.

Tension in cable $P = 23.04$ kips Sheet 4

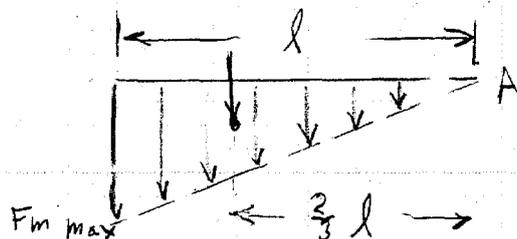
Horizontal Component = $23.04 \cos 45 = 16.29$ kips

Vertical Component = $23.04 \sin 45 = 16.29$ kips

Horizontal Component produces moment at base of lug Moment = $P_H h = (16.29)(3.5) = 57.02$ kip in

Fillet on each side of lug. Moment on one fillet = 28.51 kip in

Assume stress distribution resisting moment



Where F_m units are kips per inch of weld



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The moment resisted by the distributed stress

$$\begin{aligned} M &= (\text{Total Force})(\text{distance to center of force area}) \\ &= (\text{Average Force per inch} \times \text{length}) \times (\text{distance to center of force area}) \\ &= \left(\frac{1}{2} F_{m \max} \times l\right) \left(\frac{2}{3} l\right) = \frac{F_{m \max} l^2}{3} \end{aligned}$$

Set equal to moment from sheet 10 and solve for $F_{m \max}$

$$\frac{F_{m \max} l^2}{3} = \frac{F_{m \max} 7^2}{3} = 22.36$$

$$F_{m \max} = \frac{(3)(28.51)}{7^2} = 1.75 \text{ kips per inch of weld,}$$

From vertical force

For tension on the lug. Fillet on each side

$$\text{Vertical load on one fillet } P_v = \left(\frac{1}{2}\right)(16.29) = 8.15 \text{ kips}$$

$$\text{Load per inch of weld } F_v = \frac{P_v}{l} = \frac{8.15}{7} = 1.164 \text{ kips per inch}$$

Un. Formly distributed, The max vertical load at edge of lug is

$$F_{\max} = F_{m \max} + F_v = 1.75 + 1.16 = 2.91 \text{ kips per inch of weld,}$$



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SHEET NO. 12

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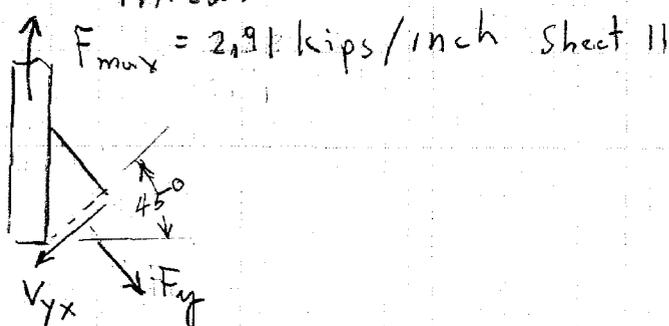
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The horizontal component produces shear on the weld parallel to the axis of the weld. The shear load is taken as uniform over the length of the weld. The shear per unit length of fillet on one side

$$V = \frac{1}{2} P_H / l = (1/2)(16.29) / 7 = 1.164 \text{ kips per inch of weld}$$

To determine maximum shear stress at the throat of the weld, the component stresses are calculated.

The vertical load produces normal and shear stress at the throat



$$\Sigma \text{ Vertical Forces} \quad 2.91 = F_{yx} \cos 45 + V_{yx} \cos 45 \quad (1)$$

$$\Sigma \text{ Horizontal Forces} \quad 0 = F_{yx} \cos 45 - V_{yx} \cos 45 \quad (2)$$

$$2 F_{yx} \cos 45 = 2.91$$

$$F_{yx} = 2.06 \text{ kips/inch of weld}$$



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From equation (2)

$$V_{yx} = F_y = 2.06 \text{ kips/inch of weld}$$

From Table J2.4 of the Specification in the Manual of steel construction, the minimum weld size for 3/4 inch plate is 1/4 inch. The area of the throat for 1 inch length of weld. To obtain a factor of safety of 3 a weld size of 9/16 is used.

$$A_t = 9/16 (\cos 45^\circ) (1 \text{ inch}) = 0.398 \text{ in}^2 \text{ For 1 inch of length}$$

$$\sigma_y = 2.06 / 0.398 = 5.176 \text{ ksi}$$

$$\tau_{xy} = 2.06 / 0.398 = 5.176 \text{ ksi}$$

$$\tau_{yz} = 1.164 / 0.398 = 2.92 \text{ ksi} \quad V = 0.913 \text{ kips/inch from sheet 12}$$

The component principal stress are determine from the solution of the cubic equation
See attached page from ASM Handbook Volume 11 Failure Analysis and Prevention

The coefficients for the cubic equation

$$I_1 = \sigma_x + \sigma_y + \sigma_z = 0 + 5.176 + 0 = 5.176$$

$$I_2 = \sigma_x \sigma_y + \sigma_y \sigma_z + \sigma_z \sigma_x - \tau_{xy}^2 - \tau_{xz}^2 - \tau_{yz}^2 \\ = 0 + 0 + 0 - 5.176^2 + 0 - 2.92^2 = -35.32$$

$$I_3 = \sigma_x \sigma_y \sigma_z + 2\tau_{xy} \tau_{xz} \tau_{yz} - \sigma_x \tau_{yz}^2 - \sigma_y \tau_{xz}^2 - \sigma_z \tau_{xy}^2 \\ = 0 + 0 - 0 - 0 - 0 = 0$$



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$$\sigma^3 - I_1 \sigma^2 + I_2 \sigma - I_3 = 0$$

$$\sigma^3 - 5.176 \sigma^2 - 35.32 \sigma - 0 = 0$$

Solution for cubic equation from
www.1728.com/cubic.htm (sheet Attached)

$$\sigma_1 = 9.07 \text{ ksi}$$

$$\sigma_2 = -3.89 \text{ ksi}$$

$$\sigma_3 = 0$$

$$\tau_{\max} = \frac{\sigma_1 - \sigma_2}{2} = \frac{9.07 - (-3.89)}{2} = 6.48 \text{ ksi}$$

Allowable stresses from Table J2.5 of the Specification
in the AISC Manual of steel construction.

$$\tau_{\max \text{ allowed}} = (0.30) F_u$$

$$\text{For weld filler metal } F_u = 70 \text{ ksi } \tau_{\max \text{ allowed}} = (0.3)(70)$$

$$\tau_{\max \text{ allowed}} = 21 \text{ ksi}$$

$\tau_{\max} = 6.48 < 21 \text{ ksi}$ allowed and $9/16$ fillet weld
is adequate for maximum shear stress at
the throat.

$$\text{Factor of safety } 21/6.48 = 3.24$$



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SHEET NO. 15

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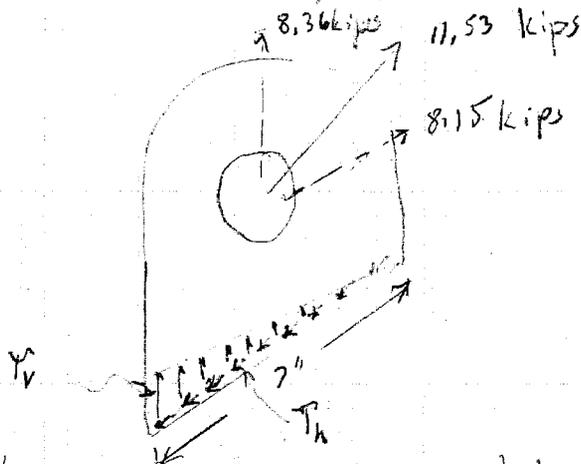
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The AISC Manual of Steel Construction limits the shear stress on the base metal to $0.4F_y$ where F_y is the yield stress of the base metal. From the sketch on sheet 10 the load P is resisted in shear by the fillets on each side of the leg.



Forces for one side of lug are $1/2$ of totals shown on sketch sheet 10.

The stresses from the horizontal component are taken as uniformly distributed. For $9/16$ fillet weld

$$\tau_h = P_h / A_w = 8.15 / (7 \times 9/16) = 2.07 \text{ ksi}$$

The stresses from the vertical component are distributed to resist the moment

From sheet 10. Moment for one side of lug $M = 28.51 \text{ kip in}$

$$\text{Moment} = (A_w \tau_v) (\text{Area of Weld}) (\text{Distance To Center of Area})$$

$$A_w \tau_v = \frac{1}{2} T_{max}$$



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$$(28156) = \left(\frac{1}{2} T_{vmax}\right) (7 \times \frac{9}{16}) \left(\frac{2}{3} \times 7\right) = 9.188 T_{vmax}$$

$$T_{vmax} = 3.103 \text{ ksi}$$

Resultant stress (Note this is maximum resultant that occurs only at the end of the lug. The resultant stress decreases to just the horizontal stress over the length of the lug.)

$$T_R = \sqrt{T_{vmax}^2 + T_h^2} = \sqrt{3.103^2 + 2.07^2}$$

$$T_R = 3.73 \text{ ksi}$$

For A36 base metal $T_{allowable} = (0.4)(36) = 14.4 \text{ ksi}$

Resultant shear stress $T_R = 3.73 < 14.4 \text{ ksi}$ allowable shear stress

$\frac{9}{16}$ inch fillet weld is acceptable.

$$\text{Factor of Safety } \frac{14.4}{3.73} = 3.86$$



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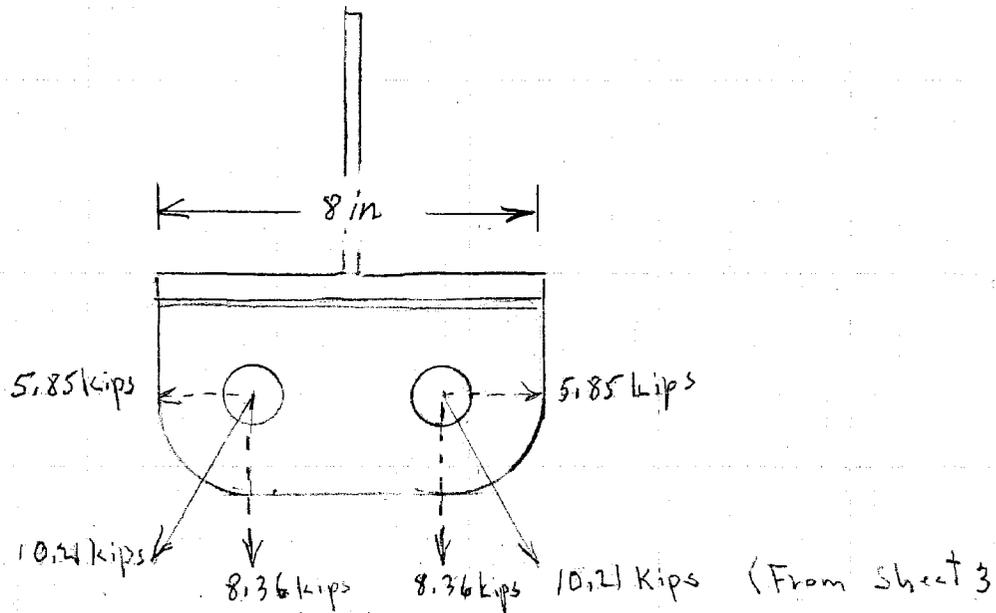
DATE 10/17/03

CHECKED BY _____

DATE _____

SCALE _____

Design fillet weld of lug on bottom of beam for connection to straps.



The horizontal components of the strap loads will balance and the only load on the weld will be from the vertical component. There are fillet welds on both sides of lug. The load per inch of weld is calculated.

$$F_v = \frac{1}{2}(2 \times 8.36) / 8 = 1.046 \text{ kips per inch of weld}$$



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SHEET NO. 18

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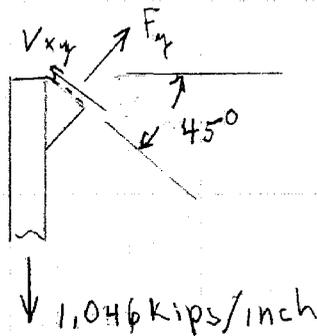
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Loads on the throat of one of the fillets are calculated



Σ Vertical Forces

$$1,046 = F_y \cos 45 + V_{xy} \cos 45 \quad (1)$$

Σ Horizontal Forces

$$0 = F_y \cos 45 - V_{xy} \cos 45 \quad (2)$$

$$2F_y \cos 45 = 1,046$$

$$F_y = 0.740 \text{ kips per inch of weld}$$

From equation (2) $V_{yx} = F_y = 0.740$ kips per inch of weld

From Table J2.4 of the Specification in the Manual of Steel Construction, the minimum weld size for $3/4$ " plate is $1/4$ " inch. A larger weld of $7/16$ " is used to obtain a safety factor of at least 3.

Area for one inch of length at the throat $A_t = (7/16 \cos 45)(1 \text{ inch}) = 0.309 \text{ in}^2$.
 The normal and shear stresses at the throat are

$$\sigma_y = \frac{F_y}{A_t} = \frac{0.740}{0.309} = 2.40 \text{ ksi}$$

$$\tau_{yx} = \frac{V_{yx}}{A_t} = \frac{0.740}{0.309} = 2.40 \text{ ksi}$$



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The maximum shear stress is calculated
(See attached sheet from Eshbach Handbook of
Engineering Fundamentals)

$$\begin{aligned}\tau_{max} &= \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \\ &= \sqrt{\left(\frac{0 - 2140}{2}\right)^2 + 2140^2} \\ &= 2168 \text{ ksi}\end{aligned}$$

Allowable value from sheet 14 $\tau_{max \text{ allowable}} = 21 \text{ ksi}$

Maximum shear from load $\tau_{max} = 2168 < 21 \text{ ksi } \tau_{max \text{ allowable}}$

1/4 inch fillet weld is adequate for maximum
shear at the throat. The Factor of Safety $\frac{21}{2.68} = 7.84$

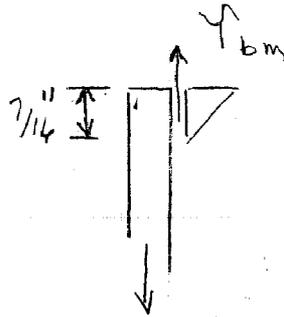
The AISC Manual of Steel constructions limits the
shear stress at the base metal to $0.4 F_y$ where
 F_y is the yield stress of the base metal.

From sketch sheet 17 the shear stress on
the base metal is produced only by the vertical
components and can be taken as equally
distributed over the fillets on both sides of the lug.



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Area of shear resistance
 $A_{bm} = 2 \times 8 \times 7/16 = 7.00 \text{ in}^2$ (Weld area sum of both sides of lug)

$$\tau_{bm} = (2 \times 8.36) / 7.00 = 2.38 \text{ ksi, Total load on lug}$$

For A36 base metal $\tau_{bm \text{ allowable}} = (0.4)(36) = 14.4 \text{ ksi}$

$$\tau_{bm} = 2.38 \text{ ksi} < 14.4 \text{ ksi} = \tau_{bm \text{ allowable}}$$

7/16 inch fillet is acceptable

$$\text{The factor of safety} = 14.4 / 2.38 = 6.05$$

REFERENCE PAGES

INEEL BBWI RFP-394 RD/RA Work Plan for WAG 1-10 ==> Crane Lifting / Loading Calculations

WAG 1-10 Sites TSF-26, TSF-03, and WRTF-01



INTEGRATED prepared Revision 0 dated - 13-Jan-2003, by DJ Kenoyer, Checked by SD Dustin

- 1 Revision 1, 24-Feb-03, by DJ Kenoyer
- 2 Revision 2, 15-Jul-03, by DJ Kenoyer
- 3 100% Rev 1, 28-Jul-03, by DJ Kenoyer / Changed Tank Thickness to be MORE Conservative to 1/4" from 3/16"
- 4 Draft FINAL, 29-Sep-03 by DJ Kenoyer / Changed Tank Thickness from 1/4" to the 1/2" found during September 2003 Tank Sampling efforts by BBWI
- 5 07-Nov-03 by DJ Kenoyer / Tank Exterior Tar Coating Thickness from 1/2" to 1" found during September 2003 Tank Sampling efforts by BBWI
- 6 20-Nov-03 by DJ Kenoyer / Tank Exterior Tar Coating Thickness 1/16" confirmed by BBWI ==> NOT 1/2" to 1" as reported earlier
- 7 01-Dec-03 by DJ Kenoyer / Tank Steel thickness 5/8" confirmed by BBWI ==> NOT 1/2" as reported earlier [Revision 4]

Original Configuration

Description	diameter (lineal feet)	length	depth	Area (square feet)	Thickness (inches)	Unit (lbs/sf)	Weight		Total (lbs)	Half-PM2A (lbs)
							Tank (lbs)	Added (lbs)		
Weight Calculations										
Specific Weight of "TAR"	72 lbs per cubic foot				5/8	25.60	61,575	4,310	65,885	32,943
					0.06	0.38	902	63	965	483
										33,425
Specific Weight of "TAR"	72 lbs per cubic foot				1/2	20.40	49,068	3,435	52,502	26,251
					0.06	0.38	902	63	965	483
										26,734
PM2A Tank	12.5	55.0		2,405.3	3/8	15.30	36,801	2,576	39,377	19,688
					5/16	12.80	30,788	2,155	32,943	16,471
Assume Tank Ribs and Manways ==>	7.0%	Added Weight			1/4	10.20	24,534	1,717	26,251	13,126
					3/16	7.65	18,400	1,288	19,688	9,844
					1/8	5.10	12,267	859	13,126	6,563

Description	width (lineal feet)	length (lineal feet)	height (lineal feet)	Length (lineal feet)	Width (lineal feet)	Unit (lbs/sf)	Weight		Total (lbs)
							THA (lbs)	Added (lbs)	
2 Weight Calculations for RUBB THA Shelter									
THA 8 Meter	26.2	65.0		40.0	26.2		5,050		5,050
				25.0		71.00		1,775	1,775
								5.0%	350
									7,175
2 Weight Calculations for RUBB Special Shelter									
THA 22'0" Walls	16.0	35.0		35.0	16.0	8.0	4,480		4,500
								5.0%	230
									4,730

Description	width (lineal feet)	length (lineal feet)	thickness (lineal feet)	Volume (cubic feet)	Unit (lbs/cf)	Weight		Total (lbs)	
						Precast (lbs)	Added (lbs)		
2 Weight Calculations for Precast "C" Section Shielding Concrete									
Sides	2	6.0	9.8	0.75	87.8	145.0	12,724	12,724	
End	1	6.0	13.8	0.75	62.2	145.0	9,024	9,024	
								4.5%	980
									22,728

Technical Specifications for Grove Mobile Hydraulic Crane GMK5240 [240 ton crane]

Boom Extension	Boom Angle	Lift Capacity	Whole Tank	Half Tank
			52,502	26,251
				26,734
				Percent Lift Capacity

(h-lineal feet)	(h-lineal feet)	(degrees)	(lbs)	99.1%	49.5%
105.0	80.0	40.4	53,000		
121.0	100.0	34.3	36,000	145.8%	72.9%
136.0	110.0	36.0	32,200		
151.0	120.0	37.4	24,800		

Distance from C/L Crane to C/L of Load ==> (h-lineal feet)

			Horizontal Distance - Crane to Tank	Lift Capacity	Percent Loading
Grove 5240 Counterweights	154,300 pounds	V-13 East Tank	80.0 h-lineal feet	53,000	49.5% 4
Outrigger Status - Extensions	100% 273" Spread	V-14 West Tank	100.0 h-lineal feet	36,000	72.9% 4
Crane Rotation Status	360 degrees	RUBB THA	26.2' x 65.0	110.0 h-lineal feet	7,175 32,200 22.3% 4
		Precast "C" Shape	110.0 h-lineal feet	22,728 32,200 70.6%	

Long High Capacity Trailers Available ==> 2003 Fontaine Specialized TDFT Telescopic Step, Drop Decl Extendable
102" wide / 48'-69" deck / 80,000 lbs capacity

			Horizontal Distance - Crane to Tank	Lift Capacity	Percent Loading
		V-13 East Tank	80.0 h-lineal feet	53,000	50.4% 4 & 6
		V-14 West Tank	100.0 h-lineal feet	36,000	74.3% 4 & 6
		RUBB THA	26.2' x 65.0	110.0 h-lineal feet	7,175 32,200 22.3%
		Precast "C" Shape	110.0 h-lineal feet	22,728 32,200 70.6%	

			Horizontal Distance - Crane to Tank	Lift Capacity	Percent Loading
		V-13 East Tank	80.0 h-lineal feet	53,000	63.1% 7 & 6
		V-14 West Tank	100.0 h-lineal feet	36,000	92.8% 7 & 6
		RUBB THA	26.2' x 65.0	110.0 h-lineal feet	7,175 32,200 22.3%
		Precast "C" Shape	110.0 h-lineal feet	22,728 32,200 70.6%	

It was noted that Eq 15 is the equation of a circle with axes σ and τ and centered on the σ axis with:

$$\text{center} = \left(\frac{\sigma_x + \sigma_y}{2} \right) \tag{Eq 16}$$

and radius, R , given by:

$$R^2 = \left(\frac{\sigma_x + \sigma_y}{2} \right)^2 + \tau_{xy}^2 \tag{Eq 17}$$

The result is that stress transformations can be performed by using the geometric principles of a circle. For example, if stresses are known at a point, they are plotted on a figure that has horizontal axis σ and vertical axis τ so that (σ_x, τ_{xy}) is the coordinate point at horizontal position σ_x and vertical position τ_{xy} and so that (σ_y, τ_{xy}) is the coordinate that corresponds to σ_y and τ_{xy} . Since the center of the circle is on the σ axis, this can be easily found by Eq 16. The radius of the circle is given by Eq 17. From this, the entire circle can be drawn. This is illustrated by the schematic Mohr's circle in Fig. 5.

Then for a rotation of axes by θ in the stress element, the position on the Mohr's circle must go through a rotation of 2θ in the same direction but around the circumference of the circle. Every point on the circle corresponds to a possible stress pair. Note that a rotation of 180° of the circle corresponds to a rotation of the stress element by 90° so that σ_x is transformed to σ_y as shown in Fig. 5.

Principal Stresses. The purpose of a stress transformation is mainly to find the stresses that can be used in a failure criterion. These would be either the largest magnitude stresses in any direction or the magnitude of stresses on a weak plane. For the former, the extreme stresses can be found by taking Eq 11 and applying the calculus principle $d\sigma_x/d\theta = 0$. That is, principal stresses are normal (perpendicular) stresses on planes for which the shear stresses are zero. The values of principal stresses are given by:

$$\sigma_1, \sigma_2 = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x + \sigma_y}{2} \right)^2 + \tau_{xy}^2} \tag{Eq 18}$$

where the positive radical gives a maximum stress labeled σ_1 and the negative radical a minimum stress σ_2 . Notice that the positions of the extreme stresses are the points on the Mohr's circle where the circle crosses the σ axis (horizontal axis) (Fig. 5).

The right side of the circle corresponds to a maximum normal stress and the left side to a minimum stress. These stresses as called principal stresses and are often labeled σ_1 and σ_2 . Notice that the extremal stress given by Eq 18 is equivalent to taking the center \pm the radius of the Mohr's circle. In this way the extreme values of stresses can be easily found by simply using the Mohr's circle.

The maximum shear stress, τ_{max} , can also be found by taking $\tau_{x'y'}$ from Eq 12 and using the calculus principal $d\tau_{x'y'}/d\theta = 0$. This results in:

$$\tau_{max} = \pm \sqrt{\left(\frac{\sigma_x + \sigma_y}{2} \right)^2 + \tau_{xy}^2} \tag{Eq 19}$$

The value of τ_{max} is the radius of the Mohr's circle, and the corresponding points on the Mohr's circle are at the top and bottom of the circle as shown in Fig. 5. The maximum shear stress could also be written as:

$$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2} \tag{Eq 20}$$

Note that the maximum normal stresses are defined at a position where the shear stresses are zero. A plane with zero shear stress is defined as a principal stress plane, that is, a plane having only normal stresses. This can be extended to three dimensions. Given a symmetric stress tensor as defined previously, a transformation is desired to a plane that results in the stress tensor having only normal stress components; all shear components are zero. This would be given by:

$$\begin{pmatrix} \sigma_1 & 0 & 0 \\ 0 & \sigma_2 & 0 \\ 0 & 0 & \sigma_3 \end{pmatrix}$$

The transformation results in a cubic equation in σ given by:

$$\sigma^3 - I_1\sigma^2 + I_2\sigma - I_3 = 0 \tag{Eq 21}$$

where

$$\begin{aligned} I_1 &= \sigma_x + \sigma_y + \sigma_z \\ I_2 &= \sigma_x\sigma_y + \sigma_y\sigma_z + \sigma_z\sigma_x - \tau_{xy}^2 - \tau_{yz}^2 - \tau_{zx}^2 \\ I_3 &= \sigma_x\sigma_y\sigma_z + 2\tau_{xy}\tau_{yz}\tau_{zx} - \sigma_x\tau_{yz}^2 - \sigma_y\tau_{zx}^2 - \sigma_z\tau_{xy}^2 \end{aligned} \tag{Eq 22}$$

The values of the coefficients, I_1 , I_2 , and I_3 are called the stress invariants and are independent of the coordinate system used to describe the stress state. However, here they are used to solve the stress cubic given in Eq 21 so that three principal stresses result: σ_1 , σ_2 , and σ_3 . In three dimensions, the maximum shear stresses can be found in the same way to the 2D stresses, that is as one-half the difference of any two principal stresses.

If stresses σ_1 , σ_2 , and σ_3 are ordered from maximum to minimum, then the absolute maximum shear stress in three dimensions is:

$$\tau_{max(abs)} = \frac{\sigma_1 - \sigma_3}{2} \tag{Eq 23}$$

The transformation of stress in three dimensions can be made with equations like Eq 14. For this transformation, a circle like the Mohr's circle

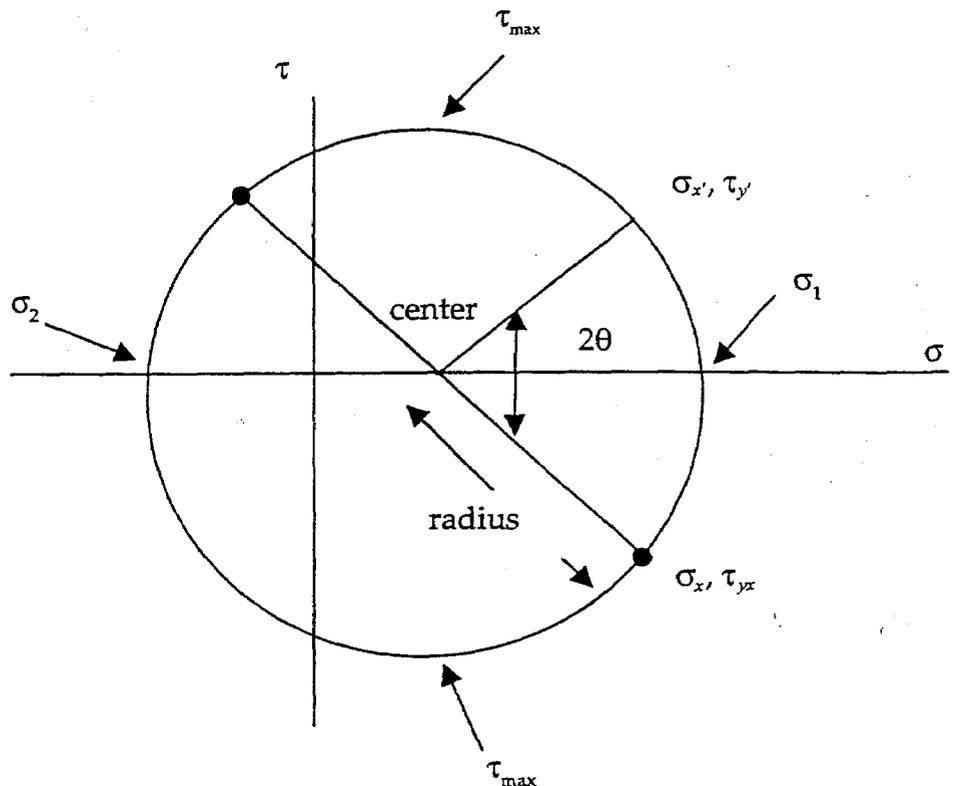


Fig. 5 Mohr's circle for two-dimensional stress transformation

Cubic Equation Calculator

Input **MUST** have the format: $AX^3 + BX^2 + CX + D = 0$

EXAMPLE: If you have the equation: $2X^3 - 4X^2 - 22X + 24 = 0$

then you would input: A= 2 B= -4 C= -22 D=24

Click **E N T E R** and your answers should be 4, -3 and 1

A= B= C= D=

E N T E R

$X_1 =$

$X_2 =$

$X_3 =$

To see the method for solving cubic equations, click [HERE](#)

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8. COMBINED STRESS

Under certain circumstances of loading a body is subjected to a combination of tensile, compressive, and/or shear stresses. For example, a shaft which is simultaneously bent and twisted is subjected to combined stresses, namely, longitudinal tension and compression and torsional shear. For the purposes of analysis it is convenient to reduce such systems of combined stresses to a basic system of stress coordinates known as principal stresses. These stresses act on axes which differ in general from the axes along which the applied stresses are acting and represent the maximum and minimum values of the normal stresses for the particular point considered.

Determination of Principal Stresses. The expressions for the principal stresses in terms of the stresses along the x and y axes are

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \quad (1)$$

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \quad (2)$$

$$\tau_1 = \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \quad (3)$$

where σ_1 , σ_2 , and τ_1 are the principal stress components and σ_x , σ_y , and τ_{xy} the calculated stress components, all of which are determined at any particular point (Fig. 1).

Graphical Method of Principal Stress Determination—Mohr's Circle. Let the axes x and y be chosen to represent the directions of the applied normal and shearing stresses, respectively (Fig. 2). Lay off to suitable scale distances $OA = \sigma_y$, $OB = \sigma_x$, and $BC = AD = \tau_{xy}$. With point E as a center construct the circle DFC . Then OF and OG are the principal stresses σ_1 and σ_2 respectively, and EC the maximum shear stress τ_1 . The inverse

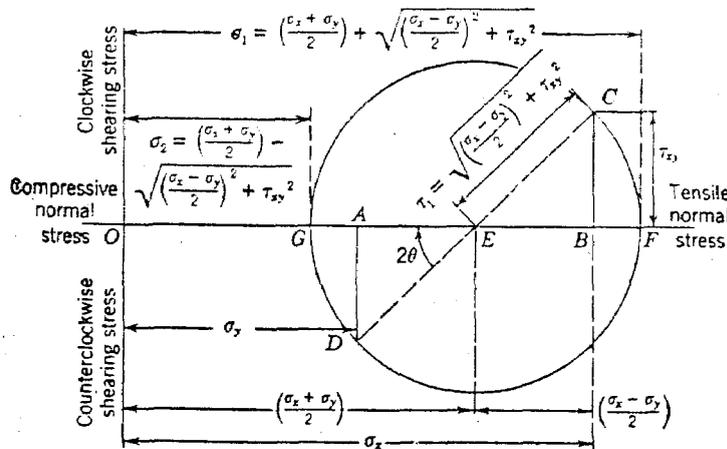


FIG. 2. Mohr's circle used for the determination of the principal stresses. (Reproduced with modification by permission from Joseph Marin, *op. cit.*)

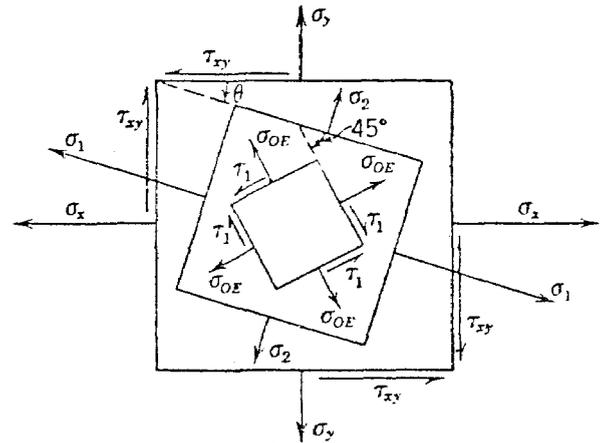


FIG. 1. Diagram showing relative orientation of stresses. (Reproduced with modification by permission from *Mechanical Properties of Materials and Design*, by Joseph Marin, McGraw-Hill Book Co.)

also holds; that is, given the principal stresses, σ_x and σ_y can be determined on any plane passing through the point.

Stress-strain Relations. The linear relation between components of stress and strain is known as *Hooke's law*. This relation for the two-dimensional case can be expressed as

$$\epsilon_x = \frac{1}{E} (\sigma_x - \nu\sigma_y) \quad (4)$$

$$\epsilon_y = \frac{1}{E} (\sigma_y - \nu\sigma_x) \quad (5)$$

$$\gamma_{xy} = \frac{1}{G} \tau_{xy} \quad (6)$$

where σ_x , σ_y , and τ_{xy} are the stress components of a particular point, ν = Poisson's ratio, E = modulus of elasticity, G = modulus of rigidity, and ϵ_x , ϵ_y , and γ_{xy} = strain components.

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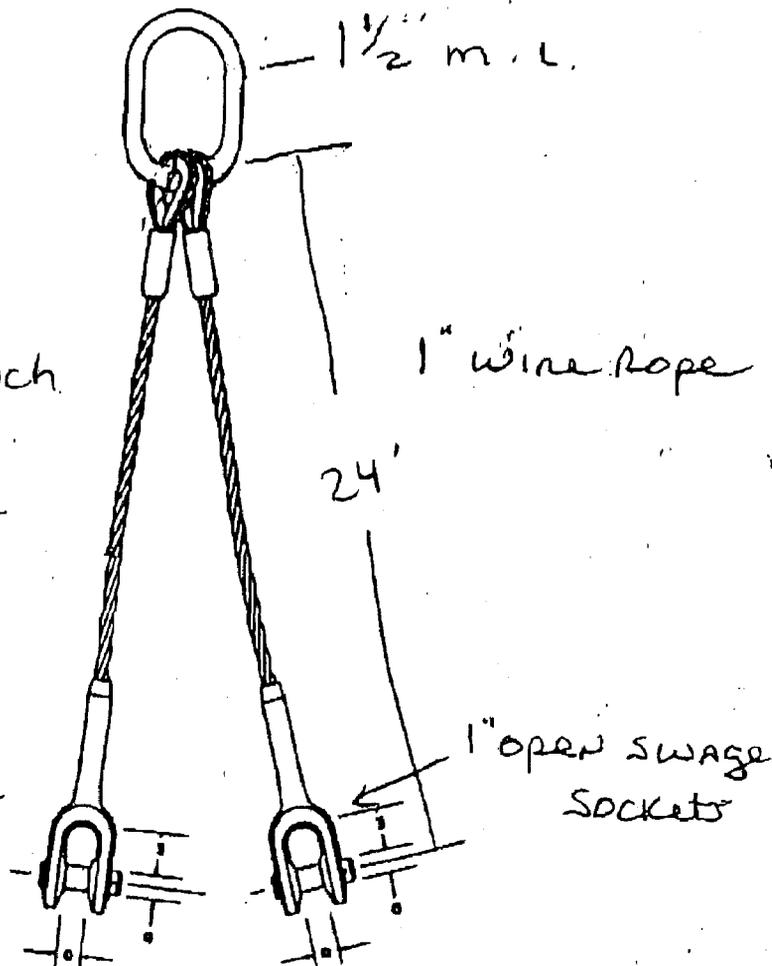
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SIZE	6 x 19 or 6 x 37 IWRC	SLING	CHOKER	BASKET	2-LEGGED SPREADER			4-LEGGED SPREADER			
		6 x 12 IWRC	6 x 18 IWRC	6 x 18 IWRC	15'	30'	45'	15'	30'	45'	
50	1/4"	56	56	42	1.1	1.1	97	79	2.1	1.9	1
75	5/16"	87	87	65	1.7	1.7	1.5	1.2	3.4	3.0	2
1	3/8"	1.2	1.2	.93	2.5	2.4	2.1	1.8	4.8	4.3	3
1.5	7/16"	1.7	1.7	1.3	3.4	3.3	2.9	2.4	6.5	5.8	4
2	1/2"	2.2	2.2	1.6	4.4	4.2	3.8	3.1	8.4	7.6	6
2.63	9/16"	2.7	2.7	2.1	5.5	5.3	4.8	3.9	11	9.5	7
3.25	5/8"	3.4	3.4	2.5	6.8	6.6	5.9	4.8	13	12	9
4.75	3/4"	4.9	4.9	3.6	9.7	9.4	8.4	6.9	19	17	11
6.5	7/8"	6.6	6.6	4.9	13	13	11	9.3	25	23	14
8.5	1"	8.5	8.5	6.4	17	16	15	12	33	29	18
9.5	1-1/8"	10	10	7.8	21	20	18	15	40	36	22
12	1-1/4"	13	13	9.6	26	25	22	18	50	44	28
13.5	1-3/8"	15	15	11	31	30	27	22	60	53	34
17	1-1/2"	18	18	14	35	35	32	26	71	63	41
21	1-5/8"	21	21	16	42	41	37	30	82	74	49
25	1-3/4"	25	25	18	49	47	43	35	95	85	57
	1-7/8"	28	28	21	56	54	49	40	109	97	66
35	2"	32	32	24	64	61	55	45	123	110	75
	2-1/4"	38	38	28	75	73	66	54	147	132	91
50	2-1/2"	46	46	34	92	89	80	65	178	159	111

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EYE EYE (FLAT OR TWISTED EYE)					ENDLESS SLINGS (MOST VERSATILE WFR SL)				
	Code	Rated Capacities in Lbs.			Code	Rated Capacities in Lbs.			
		Vertical	Choker	V. Basket		Vertical	Choker	V. B	
One Ply	EE1-801	1,600	1,250	3,200	EN1-801	3,200	2,500	8	
	EE1-802	3,200	2,500	6,400	EN1-802	6,400	5,000	12	
	EE1-803	4,800	3,800	9,600	EN1-803	8,600	6,900	17	
	EE1-804	6,400	5,000	12,800	EN1-804	11,500	9,200	23	
	EE1-805	8,000	6,400	16,000	EN1-805	13,600	10,900	27	
	EE1-806	9,600	7,700	19,200	EN1-806	16,300	13,000	32	
	EE1-808	12,800	10,200	25,600	EN1-808	19,200	15,400	38	
	EE1-810	16,000	12,800	32,000	EN1-810	22,400	17,900	44	
	EE1-812	19,200	15,400	38,400	EN1-812	26,900	21,500	53	
	Two Ply	EE2-801	3,200	2,500	6,400	EN2-801	6,200	4,900	12
		EE2-802	6,400	5,000	12,800	EN2-802	12,200	9,800	24
		EE2-803	8,600	6,900	17,200	EN2-803	16,300	13,000	32
EE2-804		11,500	9,200	23,000	EN2-804	20,700	16,500	41	
EE2-805		13,600	10,900	27,200	EN2-805	24,500	19,600	49	
EE2-806		16,300	13,000	32,600	EN2-806	26,600	23,000	57	
EE2-808		19,200	15,400	38,400	EN2-808	30,700	24,500	61	
EE2-810		22,400	17,900	44,800	EN2-810	33,600	26,800	67	
EE2-812		26,900	21,500	53,800	EN2-812	37,600	30,000	75	
Three Ply		EE3-801	4,100	3,300	8,200	EN3-801	8,000	6,400	18
	EE3-802	8,200	6,600	16,600	EN3-802	16,000	12,800	32	
	EE3-803	12,500	10,000	25,000	EN3-803	21,500	17,200	42	
	EE3-804	16,000	12,800	32,000	EN3-804	26,700	23,000	57	
	EE3-805	19,200	15,400	38,400	EN3-805	34,000	27,200	68	
	EE3-806	23,000	18,400	46,000	EN3-806	40,700	32,500	81	
	EE3-808	30,700	24,500	61,400	EN3-808	46,000	36,800	96	
	EE3-810	36,800	29,400	73,600	EN3-810	51,500	41,200	102	
	EE3-812	44,000	35,200	88,000	EN3-812	59,200	47,300	118	
	Four Ply	EE4-801	5,000	4,000	10,000	EN4-801	10,000	8,000	22
EE4-802		10,000	8,000	20,000	EN4-802	19,800	15,800	36	
EE4-803		14,900	11,900	29,800	EN4-803	28,700	21,300	52	
EE4-804		19,800	15,800	39,600	EN4-804	35,600	28,400	71	
EE4-805		24,800	19,800	49,600	EN4-805	42,200	33,700	84	
EE4-806		29,800	23,800	59,600	EN4-806	50,500	40,400	101	
EE4-808		39,700	31,700	79,400	EN4-808	57,600	46,000	115	
EE4-810		49,600	39,600	99,200	EN4-810	67,200	53,700	134	
EE4-812		59,500	47,600	119,000	EN4-812	80,700	64,500	161	

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